Water Resources Management Plan

George Washington Birthplace National Monument, Virginia

1997

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EXECUTIVE SUMMARY

George Washington Birthplace National Monument was one of the first units in the National Park System set aside for its historic value to the United States. Although the Monument was established for its cultural history, this unit of the National Park System contains significant natural resources, and in particular, water resources, that are important to the history and cultural content of the site. Within the 550-acre Monument, there is a diverse array of water-related resources, including freshwater ponds, creeks, a number of springs, and extensive areas of tidal marshes and freshwater wetlands. Additionally, the park utilizes groundwater resources as the public drinking water supply for employees and visitors.

George Washington Birthplace National Monument lies within the 64,000 mi^2 Chesapeake Bay Watershed, and along the tidal reaches of the 11,500 mi^2 Potomac River Basin. The Monument is located in a geomorphically dynamic environment, between the Potomac River and Popes Creek estuary, both of which are areas of active sedimentation and erosion. The monument land area is contained within three small subbasins: Popes Creek, Bridges Creek, and a small unnamed creek, all of which feed into the Potomac at the Monument. The combined acreage of these three subbasins is approximately 13,500 acres, of which Monument lands comprise less than 5 percent of the land area. Approximately 10 percent of the entire basin and nearly 17 percent of lands within the Monument are classified as wetlands.

Very little information exists on the condition or quality of the water resources at George Washington Birthplace National Monument, although baseline monitoring of field parameters and groundwater chemistry for supply wells is well-established. The Alliance for the Chesapeake Bay (ACB) has maintained a Citizen's Monitoring Program on Popes Creek since 1991. Volunteers for the ACB measure turbidity, temperature, pH, salinity, and dissolved oxygen concentration of the creek on a weekly basis. National Park Service employees monitor groundwater for salinity, lead, and copper in order to maintain a safe public drinking water supply. The Virginia Institute of Marine Science at the College of William and Mary has conducted periodic wetlands studies within the Longwood Swamp area of Popes Creek to document changes in wetlands area and composition of vegetation over time.

Further monitoring, inventory, and research on water resources is needed at George Washington Birthplace National Monument to more accurately document current conditions and provide park managers with information to make sound management decisions. Studies are needed to document surface- and groundwater quality and quantity, fisheries and aquatic biology, wetland delineation and mapping, wetland species composition and structure, and erosion and sedimentation rates.

The information provided through water resources-related activities at the Monument can be used by managers in resolving issues related to potential environmental impacts. Currently, surface water resources at the Monument are impacted locally by land- and water use within its three small contributory subbasins; by flooding, and erosional and depositional conditions within the Potomac River basin; and by tides, salinity, and regional basin conditions as tidal tributaries within the Chesapeake Bay watershed. Groundwater resources at the Monument are affected on a

local scale by water level and water quality in the shallow aquifer system and on a regional scale by changes in water level and water quality within deeper aquifer systems. Additional impacts to the water resources within the Monument include: local erosion and sedimentation as a result of the local geology, nutrient enrichment from historic and current land use, bacterial inputs from agriculture or septic systems, and historic and current use of pesticides and herbicides. Broader-scale impacts may include problems with transporting of industrial and municipal waste, point-source discharges of waste, and hazardous materials spills.
The natural beauty of the Monument has been protected for hundreds of years by the rural quality of the Northern Neck area. As expansion from the surrounding urban areas of Washington, D.C., Fredericksburg, VA, and Richmond, VA continues, the development of lands around the Monument becomes an even greater possibility.

In order to adequately manage the Monument's resources, a concerted water program needs to be implemented. A Water Resources Management Plan is the first step in this process. Units of the National Park Service are not required to develop a Water Resources Management Plan. However, where water resource issues or management constraints are particularly numerous, complex, or controversial, a Water Resources Management Plan is useful in providing an identification and analysis of water-related information and issues, and presenting a coordinated action plan to address them. This Water Resources Management Plan provides a description of the water resources of George Washington Birthplace National Monument, recommendations for assessing current water resource conditions and future impacts on those resources.

The four priority water resource issues identified by this plan are the needs to: 1) document baseline water quality, 2) assess the current status of wetland resources, 3) monitor land-use impacts on groundwater quality, and 4) assess historical erosional patterns and monitor areas of high potential risk. Additional projects proposed include: determining the presence of pesticide residue in sediments, researching the pathways and chemical processes between groundwater and surface water sources at the Monument, and the development of an interpretive display on water resources at the Monument.

Management recommendations or project statements have been developed to address water resource issues, where appropriate. Project statements are standard National Park Service planning and programming documents that describe a problem or issue, discuss actions to deal with it, and identify the additional staff and/or funds needed to carry out the proposed actions.

INTRODUCTION

George Washington Birthplace National Monument is a 550-acre unit of the National Park System located in Westmoreland County, Virginia, along the bank of the tidal portion of the Potomac River. It is a site rich in history as well as in flora and fauna. The site has changed little since the 16th century, for it remained a farm in a rural community until 1896, when an obelisk commemorating the birth of George Washington was dedicated, marking the Federal presence for the first time. In 1932 the site, with other purchased and donated tracts, was donated to the Federal Government by the Wakefield National Memorial Association, becoming one of the first units of the National Park System to be set aside for its historic value -- as home to George Washington and his immediate ancestors.

Although preservation of the historical setting at the Monument has been the primary focus of the National Park Service, increasingly the National Park Service and conservationists are realizing that preserving the Monument also means preservation of the natural setting that still reflects that earlier natural history of the United States. Consequently, protecting the water resources of this site is an important part of preserving the history of George Washington Birthplace National Monument.

Few paintings, drawings, maps, or detailed written descriptions exist for Westmoreland County and the Northern Neck area of Virginia during George Washington's lifetime and those of his ancestors. However, a description of major landscape patterns and features may be inferred from journals, letters of visitors, deeds, wills, surveys, and archaeology, as well as historians' knowledge of the culture and agricultural practices (National Park Service, 1987). A survey completed by George Washington early in his career, for example, documents not only the landscape and features of the Monument during his lifetime, but also his presence there as an adult.

Information about the water resources of the area prior to and since colonization also may be inferred, from knowledge of human needs, technology, and the culture of the time. The surface-water and land resources in the area around George Washington Birthplace National Monument were used for fishing and farming for centuries by the Algonquin Indians prior to arrival of the colonists. Much of the land was cleared by the Indians for farming. Oysters were a staple food for local Indians, and remains of oyster middens in the area show that the Indians probably had a fishing camp on the site at some time (West Main Design Collaborative, P.C., 1996).

Fresh water was needed for human consumption, for livestock, and for crops, so access to springs or freshwater streams was necessary. At least three natural springs have been documented in the immediate area. Streams and rivers were used as markers for boundaries, and water was a major mode of transportation for Indians as well as colonists. Once the colonists arrived, this area along the Potomac River was convenient for shipping New World products to Europe, as well as for local transportation. Tobacco and other crops could be loaded into ships and boats anchored in the Potomac River, a major thoroughfare. The same features that made the site usable by the Native Americans made it attractive to the colonists - a nearby source of transportation, level land, and fresh water.

George Washington Birthplace National Monument (GEWA) is bordered on three sides by water (fig.1). The Monument as it is today consists of a variety of ecosystems, including beaches, freshwater and brackish wetland areas, manmade ponds, fields, and forests, some of which are decidedly different than when George Washington was in residence, but many of which are similar in character. Documentation of the current water resources will provide a baseline of information for the protection of these resources, and will serve as a benchmark for comparison to resource condition in the future.

WATER RESOURCES MANAGEMENT PLAN

Water is a significant resource within units of the National Park System, whether in support of natural systems or providing for visitor use. The National Park Service (NPS) seeks to carefully manage the use of water and strives to maintain the natural quality of surface waters and ground waters as integral components of the park aquatic and terrestrial ecosystems. In addition, the health of the aquatic ecosystem as well as water-based recreation are dependent upon the maintenance of adequate water supply.

Water resource inventory, monitoring, and planning activities are, therefore, integral components of resources management at George Washington Birthplace National Monument. The purpose of this Water Resources Management Plan is to assist NPS personnel in the management of these resources by providing a description of the Monument's water and water-related resources, evaluating water-related management issues, and providing recommended actions for addressing these issues.

Data used to develop this Water Resources Management Plan were compiled from the existing body of data and literature available from government agencies, local universities, and other entities with a knowledge of water-related conditions in the vicinity of the Monument. This Water Resources Management Plan begins with a description of the regional geology, hydrology and hydrologic features and available water resources-related information within the watershed. The Management Plan then identifies water resource-related issues, points out certain data and management needs and provides recommendations for addressing the concerns identified through the development of 8 project statements which can be incorporated into the Monument's Cultural and Natural Resources Management Plan.

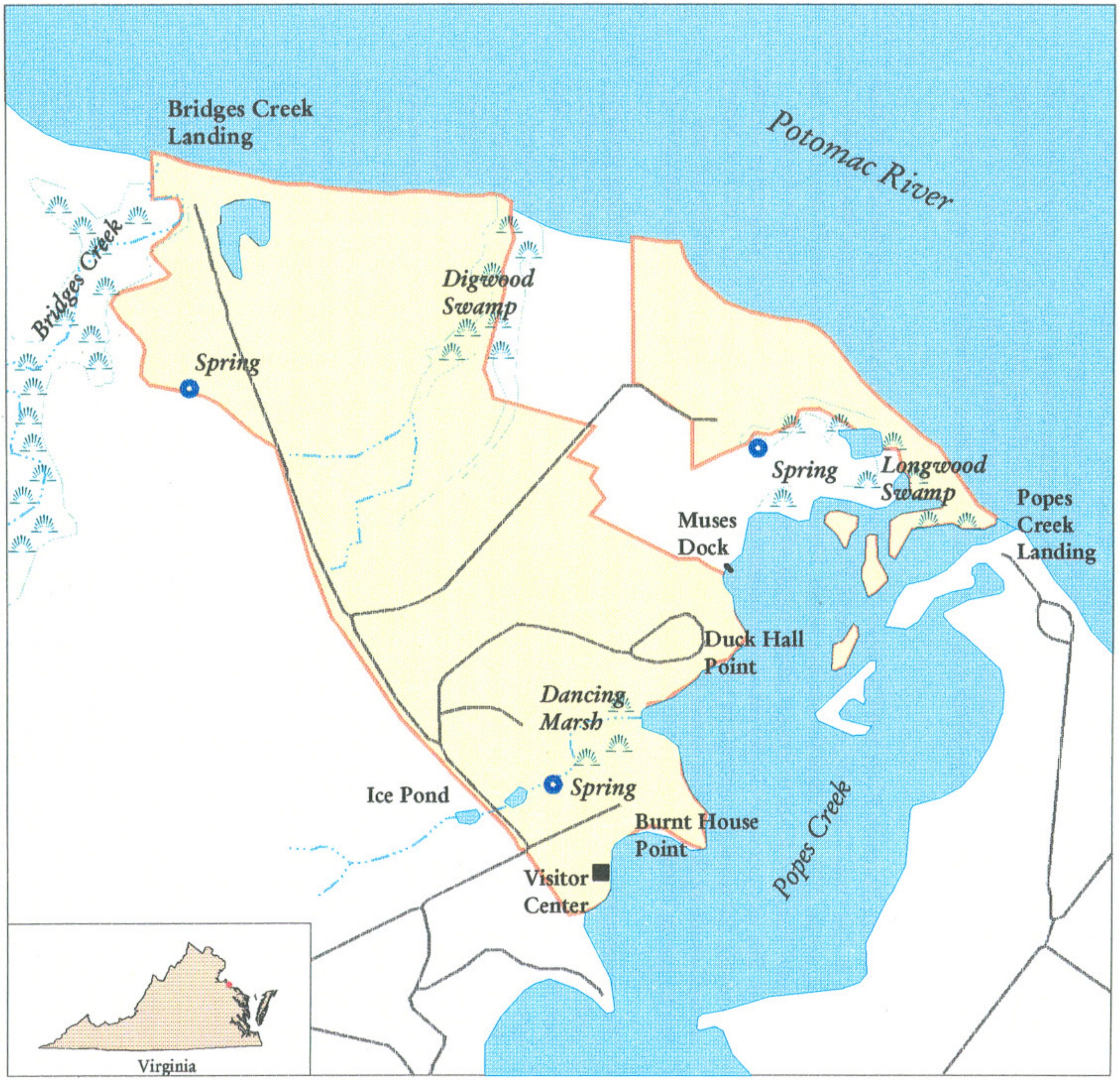

Figure 1. Generalized features at George Washington Birthplace National Monument, VA.

GEOLOGIC SETTING

George Washington Birthplace National Monument (GEWA), is located in Westmoreland County, VA, on the Potomac River about three miles southeast of Colonial Beach, Virginia, and 40 miles from Washington, D.C. Westmoreland County is within the Atlantic Coastal Plain, a physiographic region consisting of sediments that in this part of Virginia deepen from a feather-edge at the Fall Line to a depth of over 1,500 ft near the mouth of the Potomac River where it joins Chesapeake Bay, and over 5,000 ft at the Atlantic Ocean (fig. 2) (Meng and Harsh, 1988). Westmoreland County is one of several counties that comprise the peninsula known as Virginia's "Northern Neck", between the Potomac River and the Rappahannock River, extending out into the Chesapeake Bay.

The ancestral Potomac River and Chesapeake Bay have had a great influence on the surficial landforms in this area. Generally, Atlantic Coastal Plain sediments are unconsolidated interbedded gravel, sands, silts, and clays (Meng and Harsh, 1988). Sediments were periodically eroded by the ancestral Potomac River to form multiple levels of terraces, which still are evident in the landscape. The terraces were deeply incised by streams as seas receded. These high (relative to current sea level), flat terraces continue to be vulnerable to erosion along the banks of the Potomac River, as well as along the smaller creeks that lead to the Potomac River. These unconsolidated sediments are undercut in response to flooding, wave action, and/or direct precipitation and erosion.

The environment in which sediments are deposited ultimately affects both the resulting geology and the associated hydrology, including the capacity for sediments to conduct water (hydraulic conductivity), the chemical composition of the formations, and the dissolved constituents of the groundwater in contact with the formations. Meng and Harsh (1988) documented the overall hydrogeologic framework, or framework of aquifers, confining units and the depositional environment, for the entire Virginia Coastal Plain. In addition, recent investigations at the Dahlgren Naval Weapons Station, approximately 10 miles upriver from George Washington Birthplace National Monument, document the geology and geohydrology of shallow parts of the system to a depth of approximately 100 feet (Bell, 1996; Harlow and others, 1996). Nicholson (1981) published a soil survey of Westmoreland County describing the surficial deposits, which impacts the crops harvested and overall rotation, irrigation, and use of the land. These reports were used to provide much of the information for the physical description of the Monument that follows.

GEOLOGIC FRAMEWORK

The geologic formations that likely are present at George Washington Birthplace National Monument include those of Quaternary, Tertiary, and Cretaceous age, as shown in figure 3. The deeper, older formations and aquifers are relatively well-protected from contamination at the surface by isolation and by units of lower hydraulic conductivity. More recent periodic erosion and deposition resulted in shallow formations, some of which are interconnected and may act as local aquifers. With surface features such as scarps and streams that incise the aquifers to different depths, it is impossible to define region-wide routes of flow in the uppermost aquifers, except in general terms or within a very specific area.

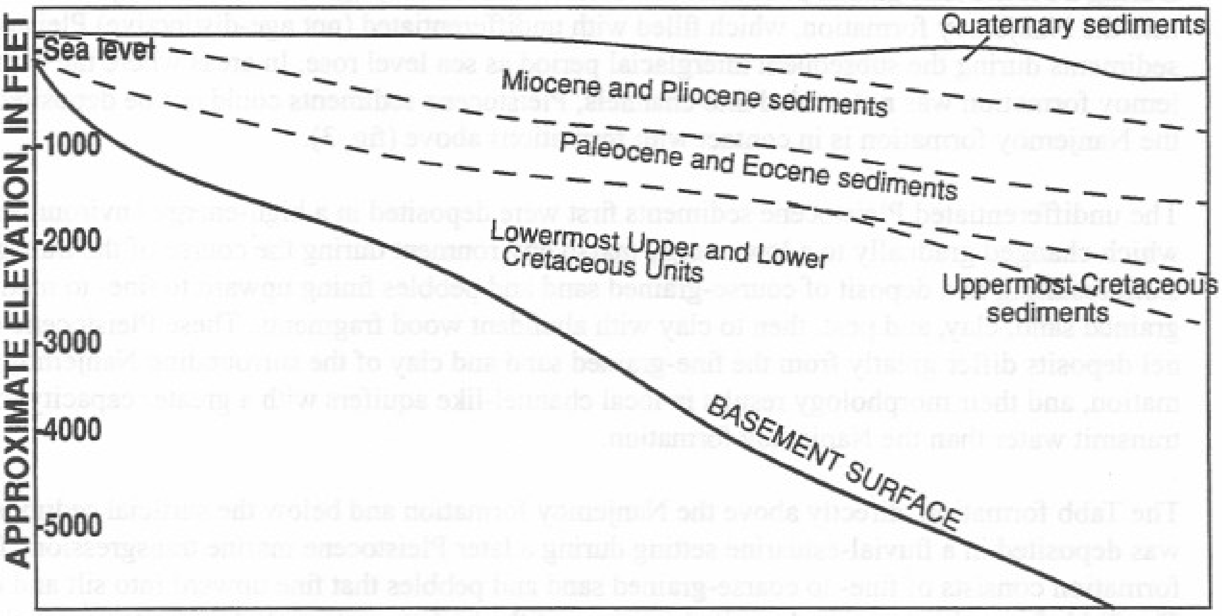

Figure 2. Generalized geologic section showing eastward-thickening wedge of Virginia Coastal Plain (adapted from Meng and Harsh, 1988).

The base geologic unit for the shallow aquifer system (defined for this report as less than 100 feet) is the Nanjemoy Formation of Eocene Age. Historically, sediments of the Nanjemoy Formation were deposited in a protected marine shelf, in water that ranged from 50 to 230 ft deep, resulting in sediments that consist of glauconitic (indicating deposition in a marine environment) fine-grained sand and clay with abundant bivalve fossils, and glauconitic silty sand. During several Miocene, Pliocene, and Pleistocene marine transgressions, additional sediments were deposited over the study area that subsequently were removed during the late Pleistocene.

During a Pleistocene glacial period, fluvial erosion incised deep (greater than 80 ft) paleochannels into the Nanjemoy formation, which filled with undifferentiated (not age-distinctive) Pleistocene sediments during the subsequent interglacial period as sea level rose. In areas where the Nanjemoy formation was not eroded into channels, Pleistocene sediments could not be deposited and the Nanjemoy formation is in contact with formations above (fig. 3).

The undifferentiated Pleistocene sediments first were deposited in a high-energy environment which changed gradually to a low-energy marsh environment during the course of the transgression, resulting in a deposit of course-grained sand and pebbles fining upward to fine- to medium-grained sand, clay, and peat, then to clay with abundant wood fragments. These Pleistocene channel deposits differ greatly from the fine-grained sand and clay of the surrounding Nanjemoy formation, and their morphology results in local channel-like aquifers with a greater capacity to transmit water than the Nanjemoy formation.

The Tabb formation, directly above the Nanjemoy formation and below the surficial sediments, was deposited in a fluvial-estuarine setting during a later Pleistocene marine transgression. The formation consists of fine- to coarse-grained sand and pebbles that fine upward into silt and clay. The Tabb formation was not deposited on some of the higher, previously formed terraces, since the ocean was at a lower relative elevation when this formation was created; instead, only lower land areas were inundated and deposited with the swamp and marsh mud, sand, and peat which became the Tabb formation.

The surficial deposits are a mixture of alluvial, paludal, and fill, over which is the relatively thin soil mantle. The most notable landforms in the area around the Monument are scarps, or steep slopes, residual of the marine transgressions. Bell (1996), and Harlow and others (1996) term the scarp that runs through Dahlgren and near the Monument the "Dahlgren Scarp" which is probably equivalent to the regional Surrey Scarp (Clifton Bell, U.S. Geological Survey, Richmond, VA, oral commun., 1997).

A study by Miller (1986) documents possible erosional processes of the shoreline along the Potomac River as a result of discharge along the horizontal layers of sand, silt, and clay. Figure 4 shows the bank profile at the Nomini Cliffs, less than 10 miles downriver of the Monument, which shows zones of seepage- and erosional surfaces such as sand and shell, as well as zones of clay. Clay is more resistant to erosion and to vertical movement of water than sand. The high terraces which are deeply incised may be susceptible to erosion from waves and seepage, among other physical processes.

PERIOD	SERIES	GEOLOGIC UNIT	HYDROGEOLOGIC UNIT	APPROXIMATE DEPTH RANGE (FEET)
Quaternary	HOLOCENE	Alluvial, paludal, and fill deposits	COLUMBIA AQUIFER	0- 60
	PLEISTOCENE	Tabb Formation Poquoson / Lynnhaven Members	*Upper confining unit	
		Sedgefield Member and undifferentiated Pleistocene deposits	*Upper confined aquifer	
Tertiary	PLIOCENE	Not present in the study area		
	MIOCENE			
	OLIGOCENE			
	EOCENE	Nanjemoy Formation	*Upper confined aquifer --continued	25 - 95
			NANJEMOY-MARLBORO CONFINING UNIT	80 - 250
	PALEOCENE	Marlboro Clay		
		Aquia Formation	AQUIA AQUIFER	260 - 395
		Not present in the study area		
Cretaceous	LATE CRETACEOUS	Undifferentiated sediments	UPPER POTOMAC CONFINING UNIT	360 - greater than 450
		Potomac Formation	Upper Potomac Aquifer	
	EARLY CRETACEOUS		Middle Potomac Confining Unit	
			Middle Potomac Aquifer	
			Lower Potomac Confining Unit	
			Lower Potomac Aquifer	

* Sometimes present in the study area

Figure 3. Relation between geology and hydrology near George Washington Birthplace National Monument, Virginia (adapted from Harlow and Bell, 1996).

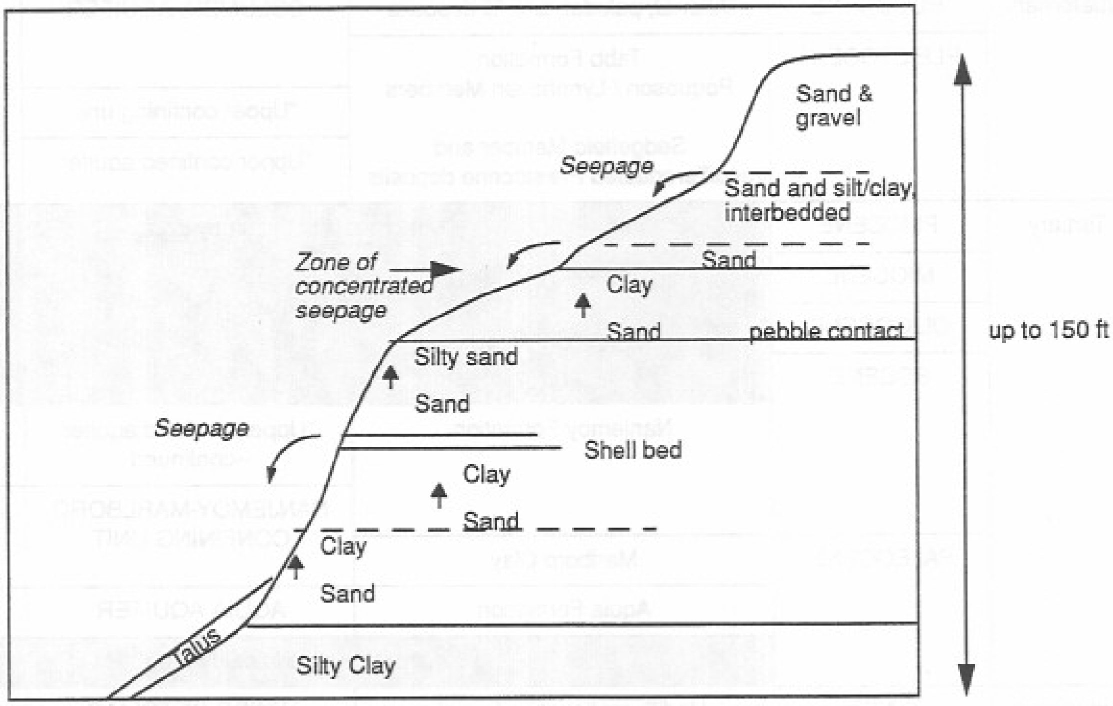

Figure 4. Generalized bank profile along the shore of the Potomac River (adapted from Miller, 1986).

SOILS

The naturally-formed terraces along the Potomac River provide a topography that in colonial time was accessible by boat, protected by steep scarps, and provided relatively flat areas for farming. According to a soil survey of Westmoreland County (Nicholson, 1981), the soil types at George Washington Birthplace National Monument and similarly northwest and southeast along the margin of the Potomac River can be differentiated from the soils further away from the river, and are linked to the terrace topography. The soils type found throughout the Monument is known as the Lumbee-Leaf-Lenoir association, defined as poorly drained and somewhat poorly drained, level to nearly level, loamy soils on the low terrace. To the west, outside the Monument boundary and on top of the Dahlgren scarp, soils are identified as the Montross-Ackwater association, moderately well drained, level to gently sloping, loamy soils on the intermediate terrace. To the south of the Monument, soils are identified as the Rumford-Kempsville-Emporia association, well-drained, steep to nearly level, loamy and sandy soils on the high terrace.

The soils on the low terrace, where the Monument is located, were deposited in a low energy environment, and so include fine particles such as silts and clays which cause water to pond rather than drain. During colonial times, drainage ditches were dug on low terraces along the Potomac River, including the area that is now the Monument, in order to drain excess water from fields for farming. The drainage ditches continue to serve as a means of keeping the fields arable today. Development in the Northern Neck may have been limited in the past partly because of these soil types, since finding land where water will percolate for septic systems continues to be difficult.

WATER RESOURCES

The local and regional geologic structure described has a great impact on controlling natural movement of water in the vicinity of George Washington Birthplace National Monument. Some effects of the geologic and hydrologic setting at George Washington Birthplace National Monument are reflected in the historic and current sources of water. Springs and seeps which discharge from the Columbia aquifer were used in colonial times for fresh water supply. There are vestiges of at least two springs used at one time on what are now Monument grounds, while the general location of a third spring, possibly the primary spring for the plantation, is known to be near the historic core portion of the Monument. The need for higher water yields, or contamination from the surface probably led to decreased use of the springs. Seeps still can be located along the bluffs along the Potomac River shore.

Currently, both groundwater and surface water resources are integral to George Washington Birthplace National Monument, for water supply and as buffers that maintain the natural beauty of the area, respectively. The interaction between groundwater and surface water is evident from historic data at the Monument with respect to the cycling of water through the soils from surface water to groundwater, in spring-fed ponds and streams, and the evidence of springs at the surface.

SURFACE WATER RESOURCES

A unique characteristic of George Washington Birthplace National Monument is that, although the site is small, the water resources of the site are impacted on-site and locally, as well as regionally. The Monument is within the Chesapeake Bay Watershed, a 64,000 mi^2 area that is extensively studied by representatives of the States of Maryland, Virginia, Delaware, and Pennsylvania, with the goal of improving the water-quality conditions of the Chesapeake Bay. The Monument is also within the Potomac River basin of the Chesapeake Bay, a 11,500 mi^2 basin that includes within its boundaries such diverse features as major cities, extensive farmlands, and mountains. The Monument is located within approximately 40 miles of the Washington, D.C., metropolitan area. Locally, the Monument primarily is within the subbasins of Popes Creek and Bridges Creek, two relatively small and undeveloped subbasins, and also includes the smaller subbasin of an unnamed creek.

Popes Creek and Bridges Creek form the east and west boundaries of the Monument. These two subbasins are separated by the subbasin of a small unnamed creek that originates in and runs through the Monument, emptying into Digwood Swamp. Although the actual streambeds of Popes and Bridges Creek are outside of the Monument boundary, the streams and associated marshlands and wildlife are an integral part of the water resources of the park, and their preservation is of vital importance to the visual and cultural preservation of the Monument. The combined drainage basin of Popes, Bridges, and the unnamed creek is approximately 13,500 acres, of which the Monument, at 550 acres, comprises less than 5 percent (fig.5).

Within these subbasins, most of the land is used for cropland, pasture, meadow, or forest. Many of the farms have been in the hands of the present owners for generations. Development in the area is centered around Route 3, and primarily consists of local stores and businesses, plus a few Colonial Beach neighborhoods in the Bridges Creek subbasin. A small portion of the Popes Creek subbasin is within the boundaries of Westmoreland State Park. Partly due to the poor surficial drainage in the area, Popes and Bridges Creeks create or have margins of wetlands not only along the Potomac River, but throughout each subbasin. The headwaters of both Popes Creek and Bridges Creek are southwest of the Monument, and probably originate from multiple springs.

Popes Creek Subbasin

Popes Creek was named after Nathaniel Pope, who patented the land in 1651. The Popes Creek subbasin is approximately 11,300 acres, and ranges in elevation from about 10 ft at the Potomac River to about 200 ft at its highest point. The major topographic features in Popes Creek subbasin are flat terraces at about 200 ft, 50-to-70 ft, and about 20 ft, each of which are deeply dissected by streams. Throughout the subbasin, the poorly drained soils result in fairly extensive wetlands around the creek. Near the Monument, the creek widens into a broad brackish estuary about 0.5 mi wide and 1.25 mi long, with an overall estimated depth of 3-to-5 ft, and a deeper main channel. Near the Potomac River, the mouth of the creek narrows, and is partially blocked by an interior delta of small, primarily shrub-covered islands. To the west of the confluence of the creek and the Potomac River is Longwood Swamp, which periodically has been examined for long-term changes in wetland vegetation (Mercer, 1978; Silberhorn and Shields, 1995; Wilcox, 1989). Dancing Marsh is within the Monument boundaries, and is fed by a creek which originates west of the Monument grounds and flows through the Monument into Popes Creek. Other formally and informally-named areas in the Popes Creek estuary include Muses Dock, where water-quality monitoring has been conducted by volunteers since 1991; Burnt House Point; and Duck Hall Point (fig. 1).

Bridges Creek Subbasin

Bridges Creek subbasin is approximately 1,960 acres, or about one-fifth the size of Popes Creek subbasin. It ranges in elevation from about 10 ft at the Potomac River to about 60 ft at the western edge of the basin near Route 3. In the upper Bridges Creek subbasin, the creek feeds directly into a pond created years ago by construction of a dam that permitted a private road across the creek. Aerial photographs from the 1950's to the 1990's show the gradual silting up of the lower half of Bridges Creek following the construction of the road, reducing open water in Bridges Creek, and creating what is now an extensive marsh, with only a small area of open water. The creek discharges into the Potomac River. The actual location of the Bridges Creek/Potomac River confluence shifts, depending on flow and deposition from each of the streams.

Other Surface Water Features

The subbasin for the unnamed creek begins just west of the Monument boundary. The creek appears to originate on the Monument from the man-made drainage ditches mentioned earlier, then flows northward into Digwood Swamp and on to the Potomac River. This creek is located adjacent to a privately-owned farm located interior to the Monument and the Monument maintenance area, and so is not directly accessible by road. This subbasin is about one tenth the area of Popes Creek subbasin.

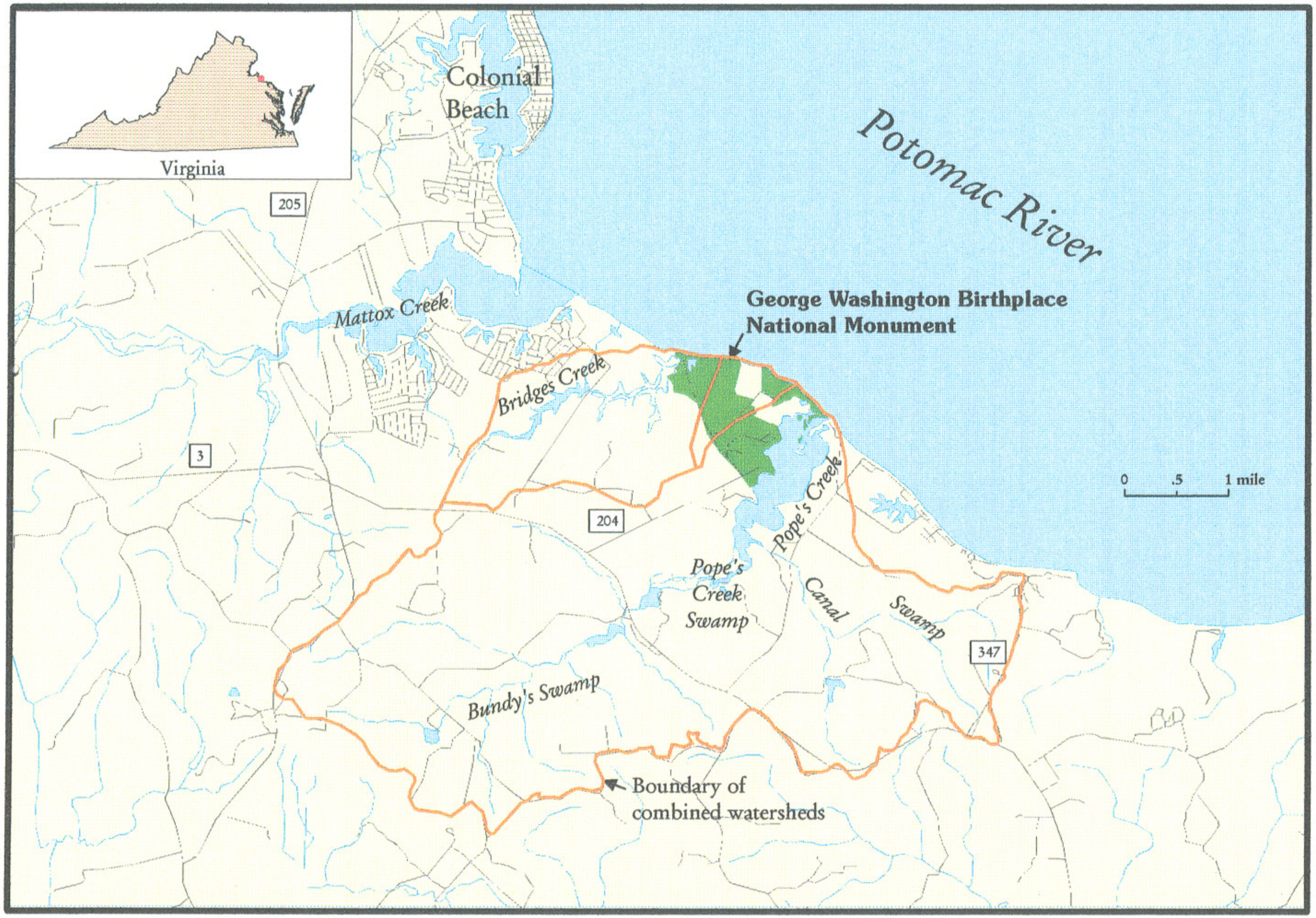

Figure 5. Location of George Washington Birthplace National Monument within three-basin watershed area.

The entire area of George Washington Birthplace National Monument is situated on the lowest terrace along the shoreline of the Potomac River. Three freshwater ponds and the unnamed creek lie totally within the boundaries of the Monument. One pond, known as Ice Pond, probably was created in the early-to-mid 1700's (West Main Design Collaborative P.C., 1996) by impounding the creek that leads through the Monument to Dancing Marsh. A second pond was created upstream when a road just west of Ice Pond was improved by the late 1800's. The upstream pond, outside the Monument boundary, is no longer maintained, and has become a small wetland that feeds into Ice Pond. The earthen dam downstream of Ice Pond was refurbished during the 1930's after not having been maintained for twenty years or more. Of the remaining two freshwater ponds, the larger is located near Bridges Creek Landing, and possibly was originally a tidal inlet impounded in the late 1800's (West Main Design Collaborative P.C., 1996). The second freshwater pond is located in the noncontiguous area of the park, beyond the private farm, and possibly was formed when a dam was put in place to create a road, although the use of the pond and the actual age are unknown (West Main Design Collaborative P.C., 1996).

As previously mentioned, three springs have been documented in the area of George Washington Birthplace National Monument, each near the base of a scarp. Springs and seeps occur where there is some connection of an aquifer with the surface, so that groundwater discharges to the ground surface, and becomes part of the surface water system. Continuously-flowing streams and permanent freshwater ponds provide evidence of groundwater discharge via springs and seeps throughout the area. One documented spring was near the original John Washington site, southeast of the confluence of Bridges Creek and the Potomac River; a second was in the area that currently is not contiguous with the main Monument site toward Longwood Swamp; and a third, thought to be the main spring for the area near the memorial house, on the Pope's Creek side of the site, was reported to have "silted up". This term may indicate erosion from the slope above, or simply that the spring was failing to produce enough water to be useful. Currently, there is a spring between Ice Pond and Dancing Marsh that does not appear to have been documented, which has been used most recently by Park Service personnel for watering livestock.

Potomac River

Views of the Potomac River and the physical buffer that the river provides are of great value to visitors at George Washington Birthplace National Monument. The river is over 5 miles wide in this area, tidal, with a 2.5-to-3 ft tidal range (National Oceanographic and Atmospheric Administration, 1987). Depending on the season, the river is commonly known as "fresh-to-brackish", ranging from a salinity of less that 0.5 ppt (low oligohaline) to 17 ppt (mesohaline) as a result of the connection with the Atlantic Ocean through Chesapeake Bay (Cowardin and others, 1979). The Potomac River commonly is used for recreational and commercial boating and fishing, and is the primary shipping route into the Washington, D.C. area. In addition, the brackish conditions created in tidal creeks that are tributary to the Potomac River create ideal nursery areas for the fish and shellfish of the Potomac River and Chesapeake Bay.

The Potomac River forms the northernmost boundary of the Monument, and conditions of the river upstream naturally affect surface-water conditions at the Monument. A common occurrence is a change in streamflow as a result of storms upstream of the Monument. Increased streamflow or flooding subsequent to storms may have severe effects, including: (1) loss of sediment, nutrients, and pesticides from agricultural areas upstream that are redeposited downstream; (2) urban runoff with associated nutrients, organic compounds, and metals; (3) sewage overflow, common in many towns and cities during extreme high water events; (4) shoreline deposits of debris and sediment; and (5) bank erosion. These problems are of concern in areas throughout the Chesapeake Bay Watershed.

Sediment and associated chemical constituents that are eroded from basins upstream and carried downstream may be deposited on barrier islands, possibly reducing the acreage of wetlands located on and near the islands. Erosion along the Potomac River has been reported historically at 3.3 ft/yr, and documented at a rate of from 0.5 ft/yr (Frye, 1982), and 1.1 ft/yr (French, 1985). Silberhorn and others (1995), using aerial photography, documented an overall loss of wetlands due to erosion and overwash of barrier islands near the mouth of Popes Creek from the period 1985 to 1994.

The nearest continuous streamflow record on the Potomac River is a USGS/ VDEQ gage at the Potomac River near Washington, D.C. (USGS station 01646500), where streamflow for the 11,500 mi^2 basin upstream has been collected since 1930 (U.S. Geological Survey, 1995). The gage is used to predict magnitude of streamflow, and potential for flooding in the Potomac River Basin. The nearest continuous streamflow record on a smaller creek is a USGS/ VDEQ gage at Cat Point Creek near Montross, VA (USGS station 01668500), where streamflow for the 45.6 mi^2 basin has been collected since 1943.

GROUNDWATER RESOURCES

Groundwater conditions may be examined within both a regional and a local context. The deeper aquifers, such as the Potomac and Aquia Aquifers (fig. 3), are within formations that were deposited in an environment subjected to little erosion, and therefore are a source of water over a much wider geographic area than the shallow aquifers. These deep aquifers provide a dependable public water supply, and are utilized to a greater extent than shallow aquifers. The effects of pumpage on the deeper aquifer, however, are more difficult to assess, since data points to monitor water level and water quality are few.

The primary Coastal Plain aquifers used for water supply in the Northern Neck are the Middle Potomac Aquifer, which occurs at a depth of about 300 ft near the Monument grounds, and the Aquia Aquifer, which occurs at about 150 ft. Generally, the public water supply wells used in the area are drilled to one of these two aquifers, for use in high volume production. The Middle Potomac and the Aquia Aquifers are used by local businesses and residents and are important as regional water supplies in Virginia east of the Fall Line and throughout much of southern Maryland. The shallow aquifer system on the Northern Neck is used extensively for private water supply and for livestock and irrigation, although data on the quantities utilized are sparse. Most homeowners, however, probably use the shallow aquifers.

When the George Washington Birthplace site was deeded to the U.S. Government, National Park Service, by the Wakefield National Memorial Association in the 1930's, the expected increase in water use resulted in the drilling of wells for visitors' use, irrigation, and livestock. Additional wells were drilled in the late 1970's to supplement and improve the water systems at the Monument. The current water supply for George Washington Birthplace National Monument is from a well screened into the Potomac Aquifer, at a depth of about 360 ft.

The shallow aquifer system at George Washington Birthplace National Monument likely can be divided from surface downward into 4 hydrogeologic units: the Columbia Aquifer, the upper confining unit, the upper confined aquifer, and the Nanjemoy-Marlboro confining unit (fig. 3). The Columbia aquifer correlates with the Holocene deposits and Tabb formation, and its water-bearing characteristics are highly variable as a result of the range of depositional environments in which the formations were created. Thin layers of clay or coarse-grained paleochannel deposits can strongly affect the rates and directions of flow in the Columbia aquifer. Generally, the Tabb Formation has its most permeable sediments at its base, and the least permeable sediments near land surface; however, multiple fining-upward sequences may be present in the aquifer at any one location.

The upper confining unit correlates with the upper, fine-grained, undifferentiated Pleistocene deposits. This unit consists of plastic clay, silty sand, and clayey sand, grey in color and containing abundant organic material, including wood fragments. The upper confined aquifer correlates with the lower, coarse-grained part of the undifferentiated Pleistocene deposits, and consists of interbedded sand and clay grading downward into sand and pebbles. Because this unit was deposited in paleochannels, it probably is not present over the entire area. Hydrogeologically, the Nanjemoy-Marlboro unit acts as a poor confining unit, meaning that it may allow leakage from one aquifer to another. In some areas, the upper confining unit and the upper confined aquifer are not present, and the Columbia aquifer directly overlies the Nanjemoy-Marlboro confining unit. This contact may provide a means of water exchange between the Columbia aquifer and the Nanjemoy-Marlboro confining unit, which effectively combine to form a thick aquifer (Bell, 1996).

Geologic Data and Groundwater Data Available

Existing geologic data that may be used to define more clearly the geology of George Washington Birthplace National Monument include well records, driller's logs, and geophysical logs (on file at Virginia District Office, U.S. Geological Survey, Richmond, VA). These data are available for several wells near or on-site at George Washington Birthplace National Monument, and from a core drilled to bedrock at Oak Grove, VA. Some groundwater-quality data are also available from samples collected at the Monument in the 1970's, and may be used as limited background information. In addition, current data from the production well now used for water supply at the National Monument also are available.

Groundwater Level Monitoring

Water level is monitored in two wells at the Monument, and the hydrographs are an indication of how the respective aquifers differ. Figure 6 shows the monitored water levels in a 461 ft observation well on the Monument grounds, drilled into the middle Potomac Aquifer in 1974. This well shows a consistent decline in water levels, with a total loss of 18 feet of elevation over the data collection period of 18 years. There is an annual water level cycle, probably in response to a seasonal regional drawdown and partial recovery of the aquifer. Water levels in this aquifer tend to rise slightly during the summer months, then decrease markedly during the winter. The Potomac Aquifer extends beneath the Potomac River into Maryland, and is used as a water source throughout the Maryland and Virginia Coastal Plain.

Figure 7 shows the monthly water record for a 26-ft deep, shallow dug well. This well is representative of the surficial Columbia aquifer, and shows a seasonal pattern of high water levels in the winter that drop in the summer and fall, possibly due to evapotranspiration. Recharge of the shallow aquifer is primarily through direct precipitation. Overall, there has been no water-level decline in this aquifer during the period that monitoring data have been collected. Water levels in this aquifer would tend to show only very local effects of pumping.

A digital groundwater model that predicts groundwater conditions in aquifers of the Virginia Coastal Plain was produced in 1990 as part of a national Regional Aquifer Systems Analysis (RASA) program (Harsh and Laczniak, 1990). This model has been used to reproduce water levels and water-level change in several Virginia Coastal Plain aquifers based on hydraulic and hydrologic measurements of the aquifers, including the Middle Potomac Aquifer. However, sparse data in the Northern Neck and incomplete knowledge of conditions along the Potomac River boundary area have made it difficult to map the area of drawdown in the deeper aquifers with reliability (E. Randall McFarland, U.S. Geological Survey, Richmond, VA, pers.commun., 1997).

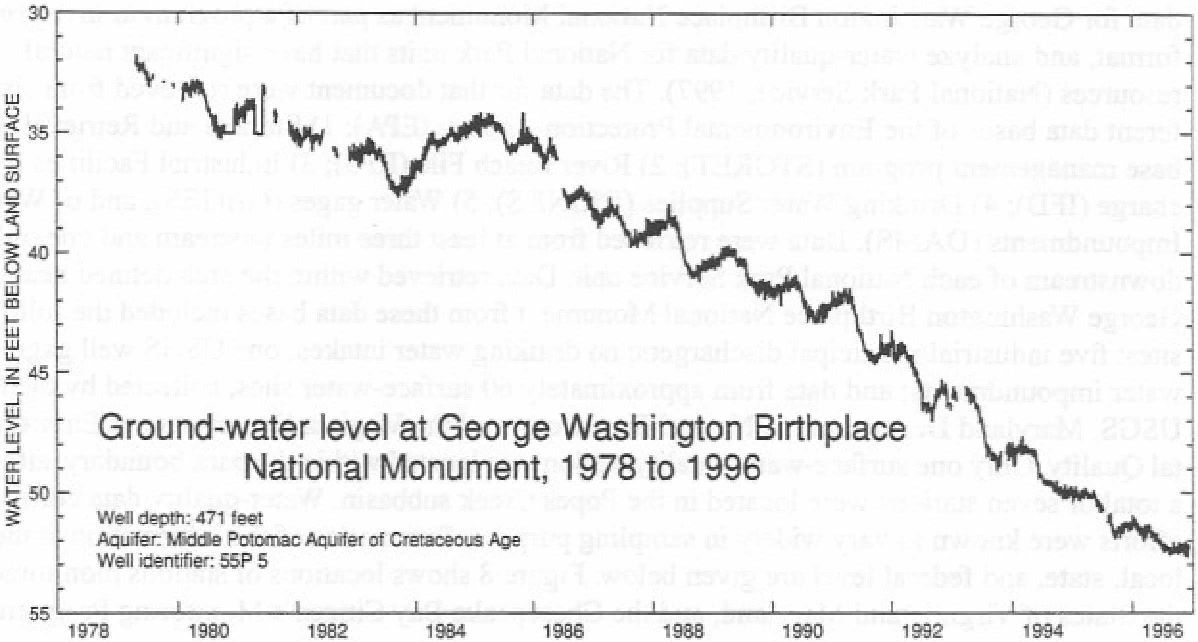

Figure 6. Ground-water level of deep well, in feet below land surface, at George Washington Birthplace National Monument (Don Hayes, U.S. Geological Survey, written commun., 1997).

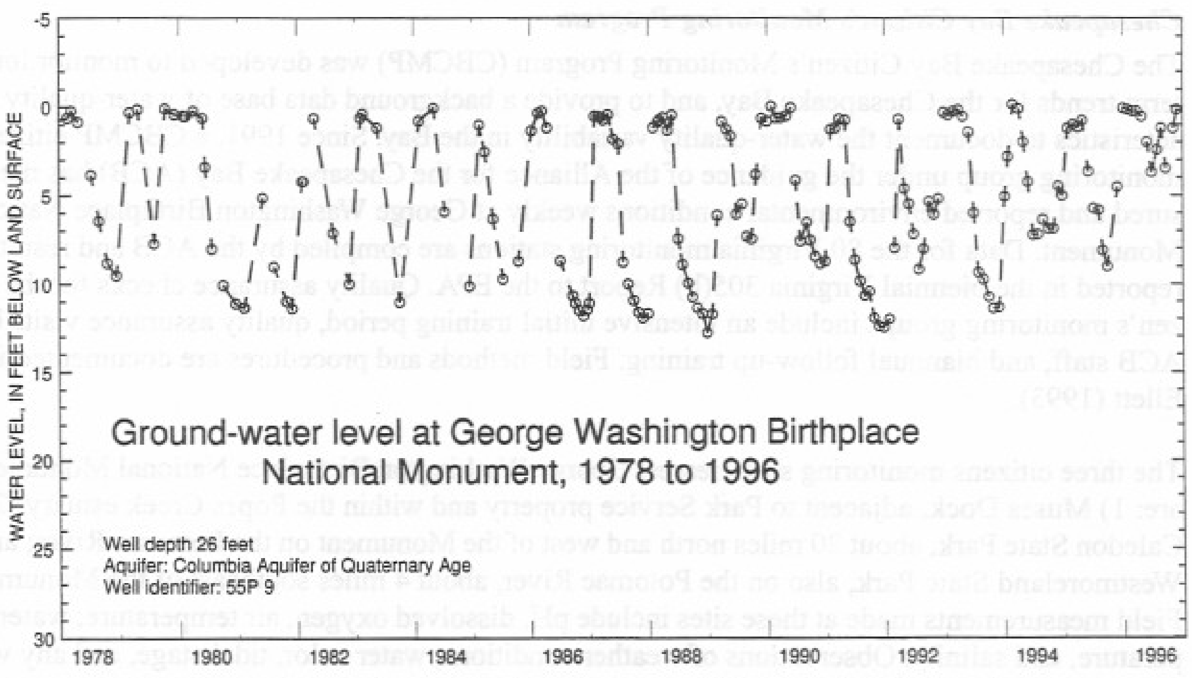

Figure 7. Ground-water level of shallow well, in feet below land surface, at George Washington Birthplace National Monument (Don Hayes, U.S. Geological Survey, written commun., 1997).

WATER QUALITY

In March 1997, the National Park Service published a compilation of all available water-quality data for George Washington Birthplace National Monument as part of a program to inventory, format, and analyze water-quality data for National Park units that have significant natural resources (National Park Service, 1997). The data for that document were retrieved from six different data bases of the Environmental Protection Agency (EPA): 1) Storage and Retrieval data base management program (STORET); 2) River Reach File (RF3); 3) Industrial Facilities Discharge (IFD); 4) Drinking Water Supplies (DRINKS); 5) Water gages (GAGES); and 6) Water Impoundments (DAMS). Data were retrieved from at least three miles upstream and one mile downstream of each National Park Service unit. Data retrieved within the area defined near George Washington Birthplace National Monument from these data bases included the following sites: five industrial/municipal dischargers; no drinking water intakes; one USGS well gage; four water impoundments; and data from approximately 60 surface-water sites, collected by the NPS, USGS, Maryland Department of Natural Resources, and the Virginia Department of Environmental Quality. Only one surface-water-quality station was located within the park boundary, although a total of seven stations were located in the Popes Creek subbasin. Water-quality data collection efforts were known to vary widely in sampling purpose. Summaries of the information at the local, state, and federal level are given below. Figure 8 shows locations of stations monitored by the States of Virginia and Maryland, and the Chesapeake Bay Citizen's Monitoring Program.

SURFACE WATER QUALITY

Chesapeake Bay Citizen's Monitoring Program

The Chesapeake Bay Citizen's Monitoring Program (CBCMP) was developed to monitor long-term trends for the Chesapeake Bay, and to provide a background data base of water-quality characteristics to document the water-quality variability in the Bay. Since 1991, a CBCMP citizen's monitoring group under the guidance of the Alliance for the Chesapeake Bay (ACB) has measured and reported environmental conditions weekly at George Washington Birthplace National Monument. Data for the 80 Virginia monitoring stations are compiled by the ACB and results are reported in the biennial Virginia 305(b) Report to the EPA. Quality assurance checks for the citizen's monitoring groups include an intensive initial training period, quality assurance visits by ACB staff, and biannual follow-up training. Field methods and procedures are documented in Ellett (1993).

The three citizens monitoring sites nearest George Washington Birthplace National Monument are: 1) Muses Dock, adjacent to Park Service property and within the Popes Creek estuary; 2) Caledon State Park, about 20 miles north and west of the Monument on the Potomac River; and 3) Westmoreland State Park, also on the Potomac River, about 4 miles southeast of the Monument. Field measurements made at these sites include pH, dissolved oxygen, air temperature, water temperature, and salinity. Observations of weather conditions, water color, tidal stage, and any wildlife also are recorded. Figure 9 compares the ranges and median values among the three sites for dissolved oxygen and salinity. The seasonal variation of salinity and dissolved oxygen concentration at the Pope's Creek station over the period of data collection is shown in figure 10.

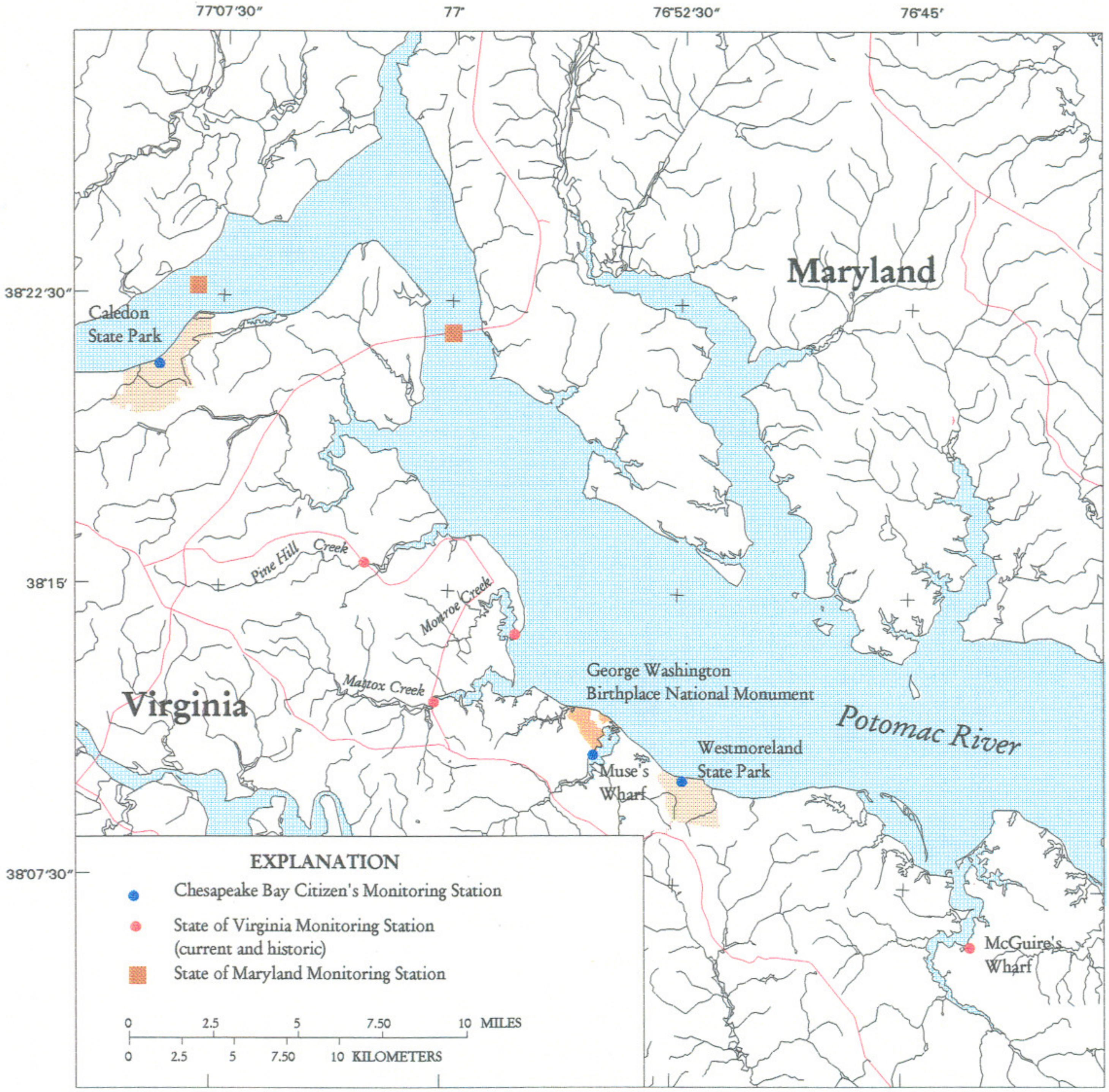

Figure 8. Monitoring stations in the vicinity of George Washington Birthplace National Monument

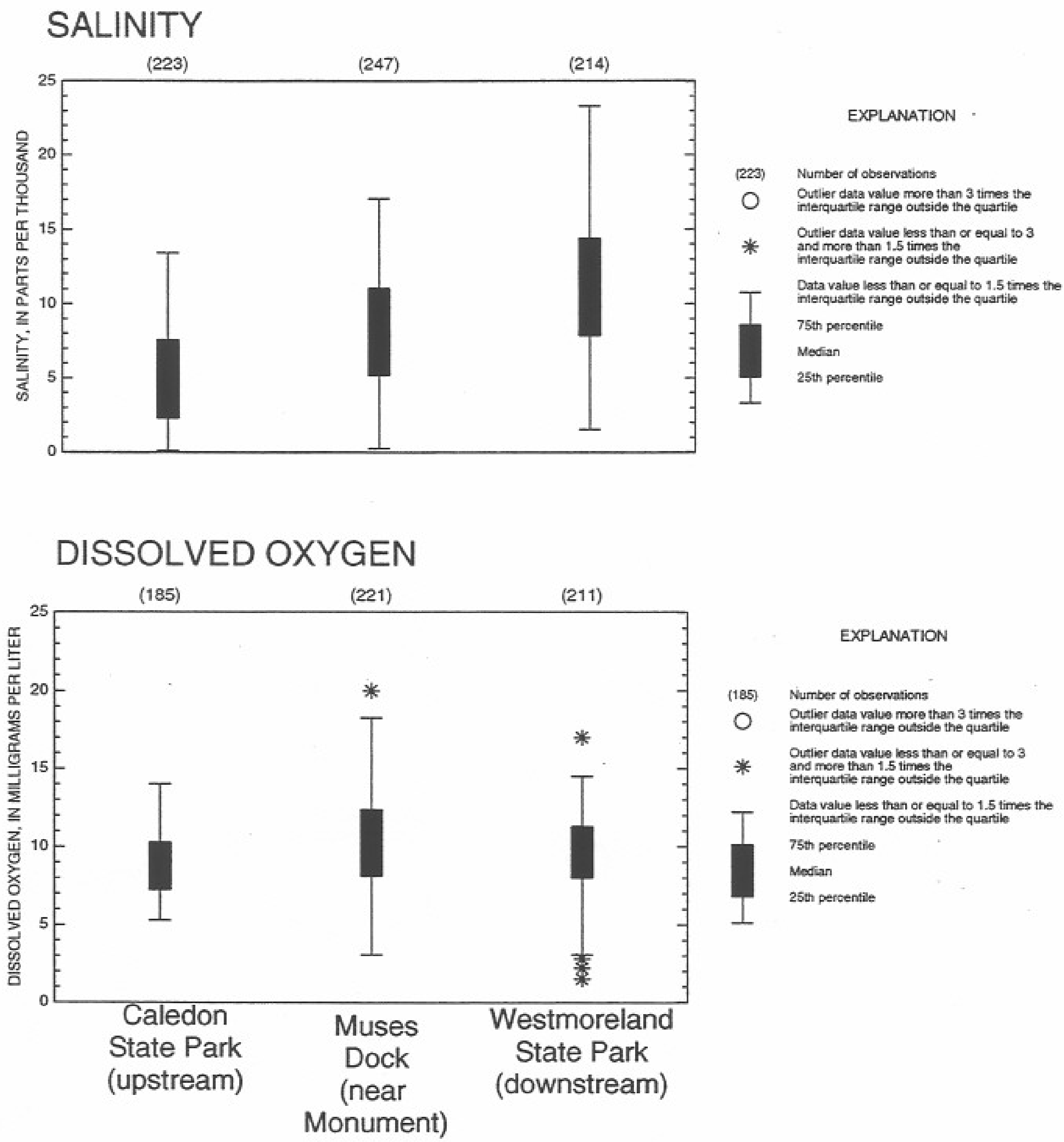

Figure 9. Results of selected field measurements at stations monitored near George Washington Birthplace National Monument by Chesapeake Bay Citizen's Monitoring Program (Joyce Brooks, Alliance for the Chesapeake Bay, written commun, 1997).

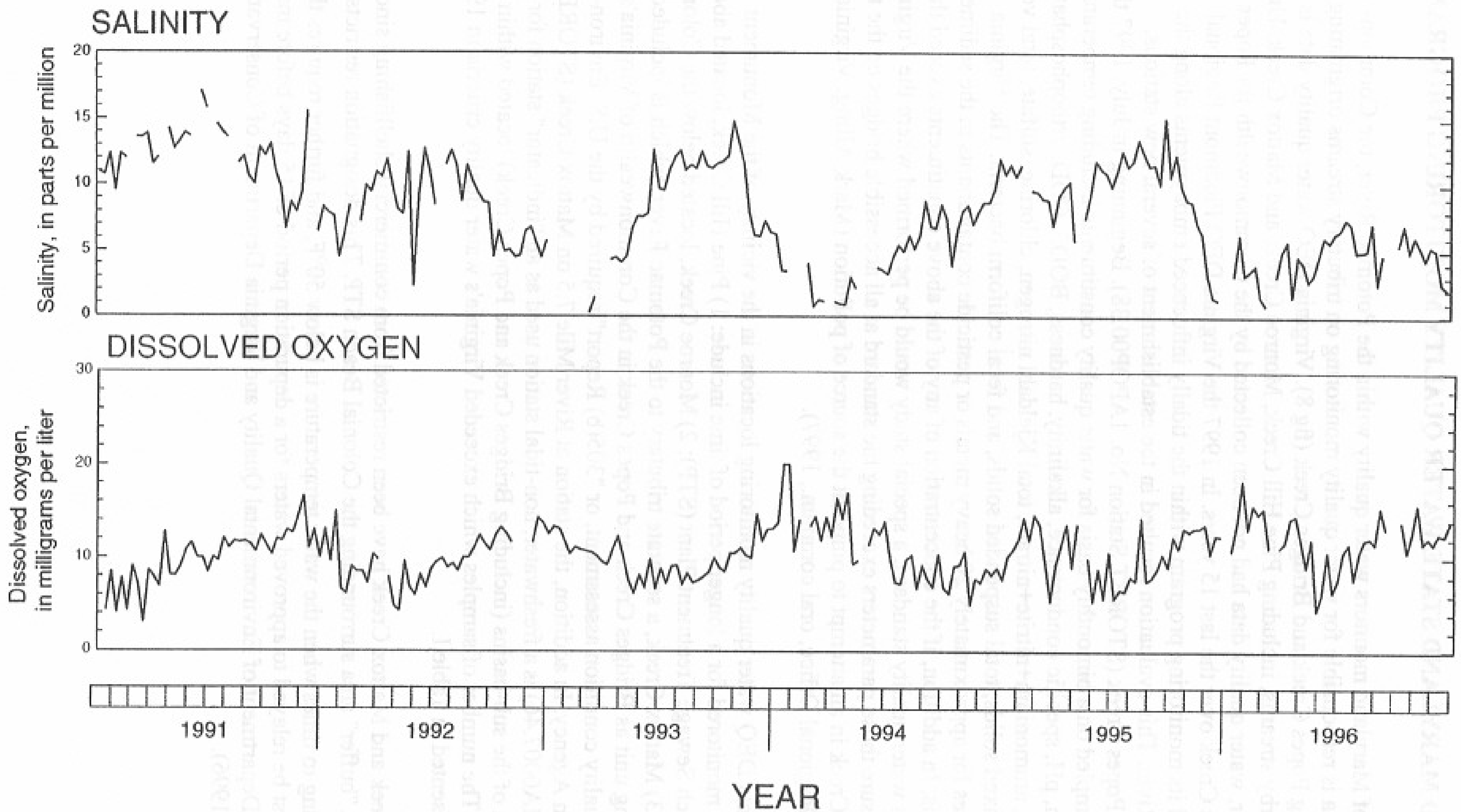

Figure 10. Seasonal variation of selected field measurement collected at Muses Dock by Chesapeake Bay Citizen's Monitoring Program (from files at George Washington Birthplace National Monument).

VIRGINIA AND MARYLAND STATE WATER QUALITY MONITORING PROGRAMS

While the State of Maryland monitors water quality within the Potomac River, the Commonwealth of Virginia is responsible for water quality monitoring on tributary streams originating in Virginia including Popes Creek and Bridges Creek (fig 8). Virginia DEQ water quality data is available for nearby streams, including Pine Hill Creek, Monroe Creek, and Mattox Creek. Until recently, however, water quality data had not been collected by the Commonwealth for Popes Creek or Bridges Creek over the last 15 years. In 1997 the Virginia DEQ Piedmont Regional Office revaluated its monitoring program within the tidally influenced embayments along the lower Potomac River. This evaluation resulted in the establishment of several new stations, including one in Popes Creek (STORET Station No. 1APOP00.38). Beginning in July, 1997 this station will be sampled on a bimonthly basis for water quality constituents including temperature, dissolved oxygen, pH, specific conductance, alkalinity, hardness, BOD5, COD, orthophosphate, total phosphorus, ammonium+nitrite+nitrate, total Kjeldahl nitrogen, chlorine, sulfate, total volatile solids, total fixed solids, total suspended solids, and fecal coliform bacteria. The Virginia DEQ also analyzes for approximately 20 heavy metals or pesticide contaminants in the sediments on an annual basis. In addition, if the concentration of any of the above constituents exceed the Commonwealth's water quality standard, a special study would be performed where the Virginia DEQ would measure those parameters exceeding the standard at all accessible bridges on the tributaries of Popes Creek in an attempt to pinpoint the source of pollution (Mark Alling, Virginia DEQ, Piedmont Regional Office, oral commun., 1997).

Additional Virginia DEQ water quality monitoring locations in the vicinity of the Monument which have been monitored for a longer period of time include: 1) Pine Hill Creek, located above the Colonial Beach Sewage Treatment Plant (STP); 2) Monroe Creek, located below the Colonial Beach STP; and 3) Mattox Creek, a separate tributary to the Potomac River, which is included in the same reporting unit as Bridges Creek and Popes Creek in the Commonwealth of Virginia's biennial water quality condition assessment, or "305(b) Report" required by the U.S. Environmental Protection Agency. In addition, the station at River Mile 7.5 on Mattox Creek (STORET Station No. 1AMA0007.46) is a freshwater, non-tidal station used as an "indicator" station for the non-tidal portion of the sub-basins (including Bridges Creek and Popes Creek) located within the accounting unit. The number of samples which exceeded Virginia's water quality criteria in 1994 and 1996 are presented in Table I.

Both Monroe Creek and Mattox Creek have been restricted from commercial shellfishing since 1931 as part of a "buffer" area surrounding the Colonial Beach STP. This designation restricts shellfish harvesting to times when the water temperature is below 50°F, and further requires that shellfish must first be relayed to approved waters for a depuration period of 15 days before marketing (Virginia Department of Environmental Quality and Virginia Department of Conservation and Recreation, 1996).

Table 1: Number of samples exceeding state water-quality criteria per total number of samples collected at state sampling stations in the vicinity of George Washington Birthplace National Monument (Virginia Department of Environmental Quality, 1994; Virginia Department of Environmental Quality, and Virginia Department of Conservation and Recreation, 1996).

	Year	Temperature	Dissolved Oxygen	pH	Coliform Bacteria
Pine Hill Creek	1994	--	1 / 9	0 / 9	0 / 9
	1996	--	1 / 8	0 / 8	0 / 8
Monroe Creek	1994	0 / 17	0 / 17	1 / 17	0 / 15
	1996	0 / 23	0 / 23	1 / 23	0 / 23
Mattox Creek	1994	0 / 8	0 / 8	1 / 8	2 / 7
	1996	0 / 23	0 / 23	0 / 23	1 / 21

Like Mattox and Monroe Creeks, Popes Creek is "restricted" from commercial shellfishing. This restriction has been in place since 1972, in response to consistent elevated fecal coliform bacterial levels. The 1990 Virginia 305(b) report states that:

> There are no known point sources within this [Mattox, Bridges, and Popes Creeks] segment. The elevated fecal coliform levels are suspected to be caused by nonpoint source inputs such as agricultural, residential and/or urban runoff, inadequate/failing septic systems, and boat pollution from public and private boat slips on the side tributaries (Virginia Water Control Board, 1990)

A closure of shellfish waters does not pertain to finfish or crabs, but to bivalve molluscan shellfish (clams, oysters, and other shellfish, based on filter-feeding ability) (Robert Croonenberghs, Virginia Department of Health, oral commun., 1997), and local fishermen continue to fish and crab within Popes Creek (John Storke, George Washington Birthplace National Memorial, oral commun., 1997).

Because the Potomac River streambed was deeded to be within the boundaries of the State of Maryland, water quality monitoring within the mainstem of the Potomac River is the responsibility of the State of Maryland. The Maryland Department of Natural Resources (DNR) maintains two Potomac River monitoring stations in the vicinity of the Monument (fig 8). These include: 1) Potomac River at the Route 301 Bridge (STORET Station No. XDC1706) and 2) Potomac River at Ragged Point, Maryland (STORET Station No. MLE2.2). The State of Maryland's 1996 305(b) report describes the water quality condition in this segment of the Potomac as follows:

High nutrient levels (nitrite, total nitrogen, orthophosphate, and total phosphorus) and elevated ammonia levels were observed in the upper third of the estuarine portion of the [Potomac River] segment [upstream of Route 301]. . . Between the Route 301 bridge and Ragged Point, total phosphorus, nitrate, and total nitrogen levels drop, but are still elevated; ammonia and orthophosphate levels remain high. Near the mouth of the river, orthophosphate levels are elevated; ammonium levels remain high. Additionally, seasonally low dissolved oxygen levels were observed in deeper waters.

A review of 11 years of water quality data collected from the lower, estuarine river (1984-1994) shows that these waters range from highly to moderately enriched by nutrients. . . An overall decrease in these indicators occurs in a downstream direction toward the mouth of the river (Maryland Department of Natural Resources, 1996).

Table 2 provides a summary of the Virginia DEQ permitted point source dischargers within an area approximately 3 miles upstream and 1 mile downstream of the Monument. Of these dischargers, only the Town of Colonial Beach is considered a major discharger (greater than 1 million gallons per day).

Table 2: Permitted dischargers from Virginia in area near George Washington Birthplace National Monument (National Park Service, 1997; Edna Jones, Environmental Protection Agency, written commun., 1997; Denise Mosca, Department of Environmental Quality, written commun., 1997)[Mgal/d, million gallons per day]

Facility Name	Latitude/ Longitude	VPDES permit number	Design flow (Mgal/d)	Receiving Water Body
Curley Packaging Company	381433 0765802	VAG524032	.002	Monroe Creek
Outdoor World Harborview	381205 0765853	VA0089087	.02	Mattox Creek
Town of Colonial Beach	381506 0765815	VA0026409	2.0	Monroe Bay
Washington District Elementary School	381100 0770040	VA0082058	.006	Upper tributary to Mattox Creek

Chesapeake Bay

Guidelines for resource preservation in Chesapeake Bay are provided to the public, to industry, and to other government agencies by a number of Federal, State and local agencies. A specific commitment by the NPS, along with many other Federal agencies, was made in the 1994 Agreement of Federal Agencies on Ecosystem Management in the Chesapeake Bay. This document commits Federal agencies to work toward bringing all Federal programs into the partnership for Chesapeake Bay ecosystem management. The agreement addresses the overall goals for the Chesapeake Bay with respect to all signatory agencies, as well as specific actions that the partnership of agencies will complete toward monitoring in the Chesapeake Bay. Some specific actions that were agreed to by the signatory Federal agencies that may apply to water resources at George Washington Birthplace National Monument include the following:

> "Support full implementation of the Bay Programs Habitat Restoration Strategy and related plans by:
> 1) including innovative use of public and private funding sources, restoration of habitat at Federal facilities, and development annually of a list of priority projects for habitat restoration on Federal lands in the watershed;
> 2) fully implementing all habitat restoration authorities to improve the conditions of aquatic, riparian and upland fish and wildlife habitat and assuring beneficial use of clean dredged material to support fish, migratory waterfowl, and other wildlife habitat in the Bay;
> 3) supporting development in the Bay watershed of a policy favoring the creation of forested buffers along streams, in order to help achieve both nutrient reduction and habitat restoration goals of the Chesapeake Bay Program. . .
>
> "Commit to do our share to meet the goal to reduce by 40% the loadings of nutrients to the Bay by 2000 through:
> 1) supporting the goals and action items of the tributary strategies as they are affected by Federal lands and programs. . .
>
> "Aid in the reduction of toxic loadings to the Chesapeake and its tributaries by:
> 1) significantly increasing the adoption of Integrated Pest Management in the watershed consistent with the Administrations commitment to having Integrated Pest Management implemented on 75% of the country's agricultural lands by the year 2000;
> 2) use the existing "BayScapes" and other successful programs to expedite compliance with the President's directive on environmentally and economically beneficial landscaping practices on Federal facilities in the Bay watershed. . ."
> (Agreement of Federal Agencies on Ecosystem Management in the Chesapeake Bay, 1994; available on the Internet at http://enviro.navy.mil/agreco.htm)

GROUNDWATER QUALITY

Groundwater is protected somewhat by its isolation from the surface. However, when groundwater becomes contaminated, cleanup is generally a long-term process because of technical constraints due to the physical isolation. Determination of the extent of a contaminated area is limited by the number of wells available from which to collect a water sample. In addition, the movement of groundwater is very slow, and natural flushing of contaminants is dependent on the local hydraulic conductivity and other conditions of the local area. Recent work in age-dating waters in the Coastal Plain of Virginia indicate that groundwater in surficial aquifers may take from years to centuries to be discharged (Hamilton and Shedlock, 1993). Chemical changes in the contaminant in the groundwater depend on such variables as the type of contaminant, the geology, and other chemical processes occurring in the aquifer.

Groundwater Quality Data Available

The aquifer and geologic structure at George Washington Birthplace National Monument indicates the need for awareness of possible routes of contamination, both to the surficial aquifer and the deeper aquifers. Although current groundwater-quality data are limited in the number of constituents that have been sampled and in the number of wells open to each aquifer, historic data show the possibility of human effects on the quality of the groundwater. Septic fields built in the early 1900's for the Monument and taken off-line in 1995 were located directly upgradient of the spring that flows into Dancing Marsh. A water-quality analysis of one of the springs at the Monument in 1944 showed a nitrate concentration of 8.4 mg/L, indicating probable contamination even at that time from leaking septic systems or direct discharge from feedlots or fields (Sinnott, 1969). Water quality analyses also are available for deeper wells for the 1970's, showing nitrate concentration ranges of <0.01 to 0.21 mg/L (unpublished files, Virginia District Office, U.S. Geological Survey, Richmond, VA).

Susceptibility of Groundwater Resources to Contamination

Because the Columbia aquifer is unconfined, the direct route of recharge into the aquifer is through infiltration of rainfall at or near the Monument, and therefore surficial conditions may affect the quality of the aquifer. The Monument site has had periods of being aggressively farmed in the past (West Main Design Collaborative, PC, 1996), which may have led to nutrient contamination of the groundwater from fertilizers or manure. Along with nutrients applied to fields in the form of man-made or natural fertilizers, there is the possibility that some hydrophilic ("water-loving", or water-soluble) pesticides also may have been transported into the groundwater. The effects of farming practices by generations of farmers may take tens to hundreds of years to move through the groundwater and discharge to the surface water.

Leaking septic systems may be another source of nutrients to the groundwater. Because there is no regional wastewater facility near the Monument, and soils in the area do not readily percolate, there are limited numbers of new septic systems in the county, which also limits the development of homes and businesses. The possibility of a regional sewage treatment facility has been discussed at the county level for the future. The change in sewage disposal methods would protect the groundwater and surface water from contamination through septic systems, but may allow for increased density of housing which, if unplanned for, potentially could have a negative effect on the historic landscape and the water quality in Westmoreland County.

Below the Columbia aquifer, there is less possibility of contamination. However, the upper confined aquifer within the Pleistocene paleochannels may be subject to contamination if wells drilled into those units were not sealed properly, or if other means of recharge to the paleochannels exists. If ever contaminated, the paleochannels could act as conduits for movement of the contaminant. In addition, in areas where the upper confining unit and upper confined aquifer are absent, the Columbia aquifer and Nanjemoy-Marlboro confining unit may provide a means of water exchange, effectively combining to form a thick aquifer (Bell, 1996). In those areas, there is potential for contamination from the surface through to lower aquifer units.

The deepest units from which water is withdrawn are susceptible to water-quality changes due to encroachment of waters higher in sodium chloride in the aquifer as the groundwater level drops from regional usage. Because the deeper aquifers are regional, development within Virginia and in Maryland leads to increased withdrawals across the area, resulting in decreased quality of groundwater.

SEDIMENTATION

Because sediments in the area tend to be unconsolidated, both erosion and deposition occur along the Potomac River and within the Popes and Bridges Creek basins. Based on reports by Singwald and Slaughter (1949), Green (1961), and Zabawa and Ostrom (1982), French (1985) concludes that any erosion up to about 8 ft/yr could be considered "normal" within the Chesapeake Bay or lower Potomac River region.

Erosion occurs as a result of the undermining of cliffs when the Potomac River is high, or from long-term seepage and natural weathering. Sources of sediment to the system include the Potomac River, which may deposit sediment at and within the mouth of Popes Creek; erosion and slumping of slopes alongside of streams; and soil carried by runoff from fields in the upper part of Popes Creek Basin, all of which could move sediment into Popes Creek estuary.

At the land-water interface along the northern border of the park French (1985) estimated that there are 1500 ft of unstable cliffs ranging up to 15 ft high, and 1800 ft of low-lying beach and marshland. Along Popes Creek at the southwestern boundary of the park are 2700 ft of cliffs similar to those along the Potomac, and 2100 ft of marshland. Below the topsoil are interbedded clay layers that resist water movement vertically, and cause the water to discharge at the cliff, which then undermines the cliff and can cause slumping and reduction of land area at the land-water border.

An unpublished report by Frye (1982) estimated the erosion rate along the Potomac River at the Monument as 3.5 ft/yr. This estimate was based on the average of erosional and accretionary areas along the land-water boundary. Using the U.S. Geological Survey Historical Erosion Quadrangle Map of Colonial Beach North (1968), French (1985) calculated a lower average erosion rate at about 1 ft/yr, with significantly higher erosion rates occurring during severe storms.

French (1985) also reported that the greatest erosion had occurred at the sandy spit at the mouth of Popes Creek, which lost 118 ft over the period from 1937 to 1982. It was suggested that this may have occurred as a result of the installation of groins upstream of Popes Creek, leading therefore to a sand-starved system. This hypothesis seems to corroborate the observation by Wilcox (1989) that channel size has increased at Longwood Swamp, with an offsetting decrease in the acreage of wetlands.

Dredging has occurred in Popes Creek at least once, when Dancing Marsh was dredged for mosquito control (West Main Design Collaborative, P.C., 1996). With no past evidence of water depths within the Popes Creek estuary, it is difficult to determine the cycle of sediment in the estuary, and whether it is slowly getting shallower, deeper, or remaining the same.

WATER-RELATED RESOURCES

WETLAND AND RIPARIAN RESOURCES

The document Classification of Wetlands and Deepwater Habitats of the United States (Cowardin and others, 1979) is used to classify wetlands for the National Wetlands Inventory (NWI) conducted by the U.S. Fish and Wildlife Service. Wetlands are defined in this inventory by plant type, soils, and frequency of flooding. NWI maps were used to document the wetlands for most of the Bridges Creek and Popes Creek Basins using maps available in a geographic information system (GIS) format from the U.S. Fish and Wildlife Service over the internet. Figure 11 shows the distribution of estuarine, palustrine, riverine, and lacustrine wetlands in the basins where George Washington Birthplace National Monument is located. Digital NWI maps used to create this coverage were based on the Colonial Beach South, Stratford Hall, and Montross 7.5' U.S. Geological Survey Quadrangles. The digital coverages for these quadrangles were finalized in 1994, based on photo-interpretation from April 1981 (Colonial Beach South and Stratford Hall, 1:58,000), and April 1988 (Colonial Beach South, Stratford Hall, and Montross, 1:40,000) (Kathy Ruhlman, National Wetlands Inventory Center, written commun., 1997).

The combined basin area of 13,600 acres contains approximately 1,300 acres of wetlands, a little less that 10 percent of the entire area. Within the combined basins are a wide variety of wetland types, including those classified as estuarine (4 percent), palustrine (5.4 percent), and lacustrine (0.6 percent) wetlands. Wetlands are extremely important as a resource, for they are areas of primary production and also provide habitat for many kinds of wildlife. Wetlands are nurseries for fish and shellfish, and act as filters or sinks for certain water-quality contaminants. They also can provide protection from floods by slowing flow and dampening storm peaks by providing expansive areas in which to store water.

Estuaries are defined as tidal habitats and adjacent tidal wetlands that usually are semienclosed by land but with open, partly obstructed, or sporadic access to the open ocean, where water is at least occasionally diluted by freshwater runoff from the land (Cowardin and others, 1979). Popes Creek fits into this categorization as an estuary, with portions of the estuary defined as subtidal (where substrate is continuously submerged) and intertidal (where substrate is exposed and flooded by tides). Much of the open-water area of Popes Creek is classified as unconsolidated bottom, meaning that less than 30 percent of the bottom is vegetated. Other estuarine subcategories found in the combined basin area include persistent emergent broadleaf, scrub/shrub, and unconsolidated shoreline.

Palustrine wetlands are defined as all nontidal wetlands that are dominated by trees, shrubs, persistent emergent and emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity from ocean-derived salts is below 0.5 parts per thousand (ppt). Although Bridges Creek contains some intertidal estuarine areas like those at Popes Creek, wetlands in Bridges Creek are primarily palustrine. Within the area of the combined basins are palustrine wetlands identified by the following types: unconsolidated bottom, aquatic beds of submergent moss, persistent emergent, broad-leaved deciduous and broad-leaved evergreen scrub/shrub, and broad-leaved deciduous and needle-leaved evergreen.

Lacustrine wetlands in the area include the lake (Latanes Lake) formed by the road constructed over Bridges Creek, and a small open-water area in Popes Creek Basin upstream of the tides, that is greater than 2 meters deep. Under the WRI classification, both of the small lakes within the Monument are considered palustrine wetlands rather than lakes, although there are larger lakes outside park boundaries that contain lacustrine wetlands.

Within the Monument boundary, about 94 acres, or 17 percent of the total acreage is classified as wetlands, based on computations from the National Wetlands Inventory Maps. Of that wetland area, 45 percent is estuarine and 55 percent is palustrine wetlands.

Between 1979 and 1994, a series of three reports was produced under the auspices of the Virginia Institute of Marine Science (VIMS) in an attempt to document and quantify the vegetation and the change in vegetation in a selected wetland area over time. The area selected to study was a portion of the wetlands near the mouth of Popes Creek known as Longwood Swamp. Although different methods were used for each study as analytical methods improved, each study contributed to knowledge about ongoing processes at the Monument.

As part of a Westmoreland County tidal marsh inventory survey in 1979, the percentage and acreage of freshwater and brackish-water wetlands were categorized and estimated by vegetation type (Mercer, 1979). A follow-up report completed by a student at VIMS as a Master's thesis (Wilcox, 1989) documented a decrease in the acreage of marsh, and an overall shift in wetland vegetation dominated by saltbush (*Iva frutescens*) to one dominated by grasses, such as *Spartina cynosuroides, S. alterniflora and S. patens*. The percentage of saltbush reportedly decreased from 90 percent to 53 percent over that time period. Wilcox's study also estimated an average accretion rate of 6.8 mm/yr, using Cesium-137 as a tracer. This rate is well above estimate for relative sea level rise of approximately 2.6 mm/yr (Davis, 1987). Wilcox's analysis did not find a strong relation between relative elevation and species distribution. A 50 percent loss of the marsh acreage over a 50-year period was estimated using changes documented by aerial photography. Suggested reasons for this loss included: the selective loss of areas dominated by saltbush, possibly due to different erosion rates and (or) root structures between plant types; tidal and wave effects on the morphology of marshes; the abundance of parasitic plants; and plant community age structure.

A third report (Silberhorn and Shields, 1994), updated some of the information from Wilcox's report and analyzed aerial photographs from 1936 to 1994 for changes in marsh vegetation. Silberhorn and Shields found a further overall loss in marsh vegetation, due in part to the loss of several small islands, and beach overwash and sand deposition in marshes. Reinforcement of the Potomac River shoreline via groins and bulkheads between 1985 and 1990 (Hardaway and others, 1992) may have caused the observed widening of water channels in Longwood Swamp as a result of the loss of longshore sand movement. Silberhorn and Shields estimated that *I. frutescens* dominated or codominated 79 percent of the marsh system in 1994, an increase from the 53 percent reported in Wilcox's study.

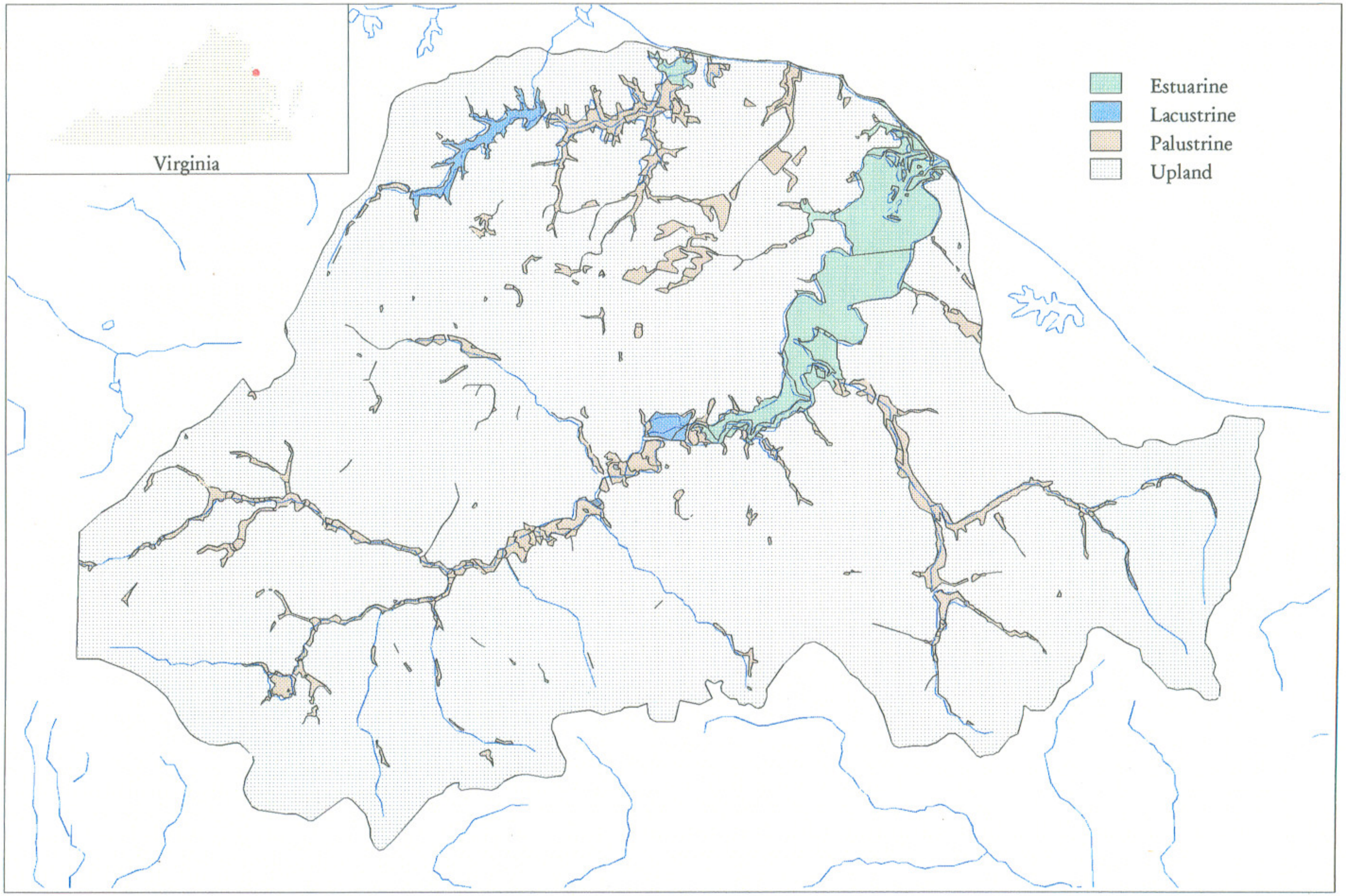

Figure 11. Wetland areas in subbasins adjacent to George Washington Birthplace National Monument.

FISHERIES

No fisheries surveys have been conducted for either Popes Creek or Bridges Creek by the Virginia Department of Game and Inland Fisheries (Dean Fowler, oral commun., 1997). Fisheries surveys are available for Upper Machodoc and Mattox Creeks, approximately 14 mi and 3 mi west, respectively, along the Potomac River from George Washington Birthplace National Monument, and for Nomini Creek, which is about 14 miles east along the Potomac River from the Monument. All three surveys were done during drought conditions in 1992, with the overall goal being to delineate the maximum upstream boundaries for saltwater fishing licenses. These surveys provide background information on the species and populations of fish found in and around tidal estuaries in Westmoreland County, and may be helpful in the future should fisheries surveys in Popes or Bridges Creeks be completed.

Like Popes and Bridges Creek, Upper Machodoc, Mattox, and Nomini Creeks are relatively undisturbed in the upper reaches, with a few small towns, and some sand-and-gravel operations and other light industry. Each subbasin has been farmed to some degree in the past. All 5 subbasins include an area of transition from a freshwater plant community to a brackish water plant community, and due to the proximity of the subbasins to each other, may be expected to have some of the same assemblages of fish and other aquatic wildlife. Unlike Popes and Bridges Creeks, however, the lower portion of each of Upper Machodoc, Mattox, and Nomini Creeks is more highly developed: Upper Machodoc Creek as part of the Dahlgren Naval Weapons Laboratory, Mattox Creek in the vicinity of the town of Colonial Beach and the Potomac River shoreline, and Nomini Creek, also along the shoreline. Each of these three basins have a much wider channel at the confluence with the Potomac River, while the channels into both Popes and Bridges Creeks are constricted. This constriction may tend to create a more controlled environment within these two basins, offering protection to some aquatic species that would not tolerate a higher energy environment. The greater range and higher concentration of salinity as measured at these 3 streams as compared to those at Muses Dock in the Popes Creek estuary (fig. 8) also may have an impact on the resulting fish population.

Sampling by Virginia Department of Game and Inland Fisheries was conducted at Upper Machodoc, Mattox, and Nomini Creeks. Fish collected included both fresh and brackish-water species. Field measurements for conductivity, salinity and depth were made at the time of sampling, and water chemistry determined for the water body at the time of sample collection. The physical and chemical data are shown in table 3. Common names of fish and the quantity collected of each species are presented in table 4.

RARE AND ENDANGERED SPECIES

A survey of the flora at George Washington Birthplace National Monument was conducted between May 1984 and May 1985. In that report, three hundred ninety-nine species of plants were recorded for the park, from ninety-three representative plant families. No rare or endangered species were discovered, although several species unusual for the area were found (Lam, G.E., 1985, The flora of George Washington Birthplace National Monument: Unpublished report on file at George Washington Birthplace National Monument).

Table 3: Field measurements and water chemistry associated with quantitative electrofishing at Upper Machodoc, Mattox, and Nomini Creeks, Virginia, June 1992 survey (Dean Fowler, Virginia Department of Game and Inland Fisheries, written commun., 1997)

	Upper Machodoc Creek	Mattox Creek	Nomini Creek
Range in Field Measurements Throughout Length of Creek			
Salinity (ppt)	0.0 - 9.0	2.2 - 7.6	0.3 - 10.5
Conductivity (µsiemens)	145 - 14,500	3,750 - 13,300	610 - 19,000
Depth (m)	0.5 - 4.3	0.3 - 3.8	0.4 - 4.0
Water Chemistry Associated With Electrofishing Runs			
pH	6.02	6.91	6.43
Conductivity (µsiemens)	81 - 205	499 - 6,900	610 - 10,100
Total Hardness (ppm)	17	425	51
Total Alkalinity (ppm)	13.6	85	27.2
Secchi depth (cm)	25	27	35

The Virginia Heritage Program and the National Heritage Program prepared a report for the National Park Service in 1993 (Ludwig and others, 1993) of rare species found during nesting season in National Parks along the Eastern United States, including George Washington Birthplace National Monument. The Survey reported only the Bald Eagle (*Haliaeetus Leucocephalus)*. However, other rare species reported to the Virginia National Heritage Program at or within a 1-mile radius of the Monument have included not only the Bald Eagle, but also the Black-crowned Night Heron (*Nycticorax nycticorax*), and the Ivy-leaved Water Crowfoot (*Ranunculus hederaceus*), a semiaquatic plant. When the 1989 report was done, the report of the heron and the Water Crowfoot were not available to the Virginia National Heritage Program, and had not been identified as possible rare species in the park. Much of the land in and around the Monument has been protected from development, so that there may be other rare species within the park.

Table 5 shows the global and State rank, and Federal and State Status for Birds and Plants that have been documented in George Washington Birthplace National Monument. Other rare and endangered species reported within Westmoreland County have included the Short-eared Owl (*Asio Flammeus)* and the following vascular plants: Sensitive Joint-vetch (*Aeschynomene Virginica),* Lake-bank Sedge (*Carex Lacustris)*, Parker's Pipewort (*Eriocaulon Parkeri)*, Wedge-leaf Thoroughwort (*Eupatorium Glaucescens), and* Spiral Pondweed (*Potamogeton Spirillus)*.

Table 4: Fish collected at Upper Machodoc, Mattox, and Nomini Creeks, Virginia, and summary data for June 1992 Survey (From files of Virginia Department of Game and Inland Fisheries, Fredericksburg, VA, and Virginia Marine Resources Commission, Newport News, VA).

Common Name	Scientific Name	Upper Machodoc Creek	Mattox Creek	Nomini Creek
American Eel	*Anguilla rostrata*	8	9	10
Atlantic Menhaden	*Brevoortia tyrannus*	3	6	5
Banded Killifish	*Fundulus diaphanus*	12	2	17
Black Crappie	*Pomoxis nigromaculatus*	10	5	
Bluegill	*Lepomis macrochirus*	7	11	
Brown Bullhead	*Ameiurus nebulosus*	17	1	8
Chain Pickerel	*Esox niger*	3	6	5
Channel Catfish	*Ictalurus punctatus*	1		
Common Carp	*Cyprinus carpio*	5		2
Creek Chubsucker	*Erimyzon oblongus*	31		
Eastern Silvery Minnow	*Hybognathus regius*	28	55	3
Gizzard Shad	*Dorodoma cepedianum*	3	14	11
Golden Shiner	*Notemigonus crysoleucas*	71	48	74
Largemouth Bass	*Micropterus salmoides*	6		
Inland Silverside	*Menidia beryllina*	9		2
Mosquitofish	*Gambusia affinis*	2	4	
Mummichog	*Fundulus heteroclitus*	6	12	1
Pumpkinseed	*Lepomis gibbosus*	42	67	79
Spot	*Leiostomus xanthurus*		3	
Striped Bass	*Morone saxatilis*	2		2
Tessellated Darter	*Etheostoma olmstedi*	1		
Warmouth	*Lepomis gulosus*		3	
White Catfish	*Ameiurus catus*	11	1	
White Perch	*Morone americana*	65	102	29
Yellow Bullhead	*Ameiurus natalis*	1		
Yellow Perch	*Perca flavescens*	56	41	45
Total Number of species		24	18	15
Total Number of fish		400	390	293
Total Biomass (kg)		45.9	17.4	19.7
Percent representative saltwater/freshwater fish		30/70	44/56	18/82

Table 5: Natural Heritage Resources of George Washington Birthplace National Monument, Westmoreland County, Virginia (Ludwig and others, 1993; Virginia Natural Heritage Program Internet site: http://www.state.va.us/~dcr/vaher.html)

Common Name	Scientific Name	Date last docu-mented	R: Rareness E: Endangerment	Rareness ranking/ Endangerment status	
** Birds					
Bald Eagle	*Haliaeetus Leucocephalus*	1997	R	Global Rank	Common
			R	State Rank	Very rare to uncommon
			E	Federal Status	Listed Threatened
			E	State Status	Listed Endangered
Black-crowned Night-heron	*Nycticorax Nycticorax*	ND	R	Global Rank	Very common
			R	State Rank	Very rare to uncommon
** Vascular Plants					
Long-stalked Crowfoot (Ivy-leaved Water Crow-foot)	*Ranunculus Hederaceus*	1984	R	Global Rank	Very common
			R	State Rank	Historically known

Global and State Rareness Rankings:

Common: usually >100 populations or occurrences, but may be fewer with many large populations; may be restricted to only a portion of the state; usually not susceptible to immediate threats.

Very rare: usually between 5 and 20 populations or occurrences; or with many individuals in fewer occurrences; often susceptible to becoming extirpated.

Rare to uncommon: usually between 20 and 100 populations or occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.

Very common: demonstrably secure under present conditions.

Historically known: Historically known within the state, but not verified for an extended period, usually > 15 years; this rank is used primarily when inventory has been attempted recently.

WATER RESOURCE PLANNING ISSUES

OVERVIEW OF EXISTING WATER RESOURCES ACTIVITIES

Management at George Washington Birthplace National Monument has supported the protection of its natural resources in the past, and increasingly has taken steps to provide protection of its resources for the future. With respect to the water resources of the Monument, the park monitors its public water supplies by conducting drinking-water chemical analyses, and plans to install a reverse-osmosis water treatment facility as a result of changes in the quality of groundwater from the deeper aquifer. Underground storage tanks once used for petroleum products have been removed, and surrounding soil tested, with no leakage found of petroleum or other hazardous products. An above-ground storage and recycling facility is used to hold petroleum products and wastes away from water supplies, and is easily monitored.

Water resources research activities involving external academic, state, and/or federal cooperators within the Monument have included: a flora survey (Lam, 1985), a report of rare and endangered species (Ludwig and others, 1993), monitoring of groundwater levels in the Columbia and Middle Potomac aquifers (U.S. Geological Survey, 1995), a series of reports on changes in wetlands vegetation (Mercer, 1978; Wilcox, 1989; Silberhorn and others, 1995), and several reports on erosion at and near the Monument (French, 1985; Frye, 1982; Hardaway and others, 1992).

Beginning in December, 1996, discussions have been held with NPS personnel, federal and state officials, and other water resource officials regarding water resource issues and management concerns at George Washington Birthplace National Monument. Specific water resource issues identified for consideration in this Water Resources Management Plan include:

* Inventory of Current Conditions
* Monitoring
* Research
* Protection, Management and Mitigation
* Education and Administration

INVENTORY OF CURRENT CONDITIONS

Many types of water-resources information, and especially surface water quantity and quality are available for the Chesapeake Bay and the Potomac River near George Washington Birthplace National Monument, primarily through state sampling programs and the Chesapeake Bay Program. Groundwater used for water supply at the Monument is periodically sampled and assessed with respect to drinking water regulations.

Much about the surface-water chemistry and related water resources at George Washington Birthplace National Monument is unknown, however. To preserve the present condition of the water resources of the Monument, a coordinated sampling plan is needed, primarily for documentation of background water quantity, water quality, and sediment chemistry for the Bridges and Popes Creek basins, as well as for the Monument. Questions to be answered include the following:

1) What is the current general in-stream and in-estuary water chemistry?

2) What concentrations of nutrients currently are found in the groundwater, in the streams and in the estuary, and can the major sources (through groundwater, surface water, or both) be defined? Is there a relation between the site history and these nutrient sources?

3) What bacterial concentrations are found, and how are they related to groundwater and surface water conditions, site history, and sources?

4) What are the sediment concentrations and discharge from source creeks into and out of the estuaries? Does Popes Creek estuary retain more sediment than is discharged at the mouth into the Potomac, resulting in silting up of the estuary?

5) Have pesticides been applied that may have been retained in the sediments of Popes and Bridges Creek?

6) Do the plant and animal communities reflect healthy conditions in the streams and estuaries?

Addressing these questions will provide a better understanding of the water resources, the current water quality, sources and sinks at the Monument.

MONITORING

The current Chesapeake Bay Citizen's Monitoring Program provides consistent water-quality field measurements in Popes Creek that are appropriate and necessary for providing background field conditions and changes in response to annual, seasonal, and tidal fluctuations. These measurements, however, are not specific to the Monument site, or in response to a question or problem in these estuaries. This monitoring is useful Bay-wide in providing data on conditions throughout the Potomac River and Chesapeake Bay. However, the current monitoring data program is not adequate for assessing more specific changes in water chemistry from present conditions.

An expanded monitoring program is needed to document the changes (increases or decreases in load or concentration) that may be occurring, what the rates of change are, possible reasons, and potential effects on the flora and fauna of the Monument. Documentation of changes in the water chemistry is important in and around the Monument, such as in response to any mitigation activities such as farming best management practices that have been instituted at the Monument. Contaminants frequently associated with farming areas that may need to be monitored include nutrients, bacteria, pesticides, and suspended sediment.

RESEARCH

This area is known to have been farmed for hundreds of years, is an easily accessible site, and both surface-water and ground-water quality can readily be monitored long-term. Research needs and opportunities at the Monument include: 1) the examination of localized surface water/ground water chemical and physical interactions within the Virginia Coastal Plain, and 2) sedimentation and erosion effects on wetlands, wildlife habitat, and other aspects of water resources in Westmoreland County. Groundwater moves at a very slow rate, and current changes to management practices may not be observed in the chemistry of the groundwater for many years. A monitoring program at the federally-protected Monument may be of great value to ongoing research on groundwater discharge rates and chemistry within the Chesapeake Bay Watershed. Examining sedimentation processes in this part of the Virginia Coastal Plain may be of use to farmers on the

Northern Neck, to examine the fate of their soils, and the loss of sediment to the system.

PROTECTION, MANAGEMENT AND MITIGATION

Figure 11 shows the areas designated as wetlands in the Popes Creek and Bridges Creek basins (Cowardin and others, 1979). Wetlands often act as sinks for water-quality contaminants by slowing streamflow and by providing areas where contaminants may be absorbed by plants or other organic material, or adsorbed onto sediment. Wetlands in the upstream parts of the basin, outside of Park Service boundaries, therefore may be chemically active and protective areas for the resources of the Monument. Protection of the Bridges and Popes Creek basins may require that Park Service administrators provide documentation to the Westmoreland County Planning Department or the Northern Neck Planning District Commission of the potential protection provided by wetland areas. Specific studies to look at and provide this information may be necessary.

In addition, expanses of wetland areas provide habitats that are not easily accessible, and therefore offer protection from humans for a multitude of animals and plants. The secluded nature of the Monument grounds, and jurisdictional protection of plants and animals in and around the Monument allow for the possible existence of unusual and rare plants and animals. A survey of rare and endangered species of plants and animals in and around George Washington Birthplace National Monument would document the current status and may allow for added protection of the wetlands and streams. There has been some documentation completed in the past on rare and endangered species (Ludwig and others, 1993); that report, however, was primarily a search of plants and animals that had already been documented or that were known to exist in the area (Chris Ludwig, Virginia National Heritage Program, oral commun.,1997).

EDUCATION AND ADMINISTRATION

Education of the visiting and general public to water resource issues at the Monument provides a rare opportunity to tie together cultural history and natural history. A focus that is separate from the human history of the Monument but is included in the interpretation at the site may serve to integrate the two in the mind of the public, and may make environmental studies more real-to-life for students, teachers, and the public. One example is the known reliance of the Indians on the water resources for food, and the archeological remains of oyster middens that display that history. Also, the use of ground water and springs versus surface water for the use of a family offers important clues to the colonial way of life. The Monument offers clear opportunities to actually display to the public both surface water and ground water, and relate them to the expansion and changes at the Monument through time.

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ACKNOWLEDGEMENTS

This Water Resources Management Plan was undertaken as a cooperative effort between the U.S. Geological Survey and the National Park Service. The author would like to thank John Donahue, Superintendent, and John Karish, Chief Scientist, Chesapeake and Allegheny Support Office for their assistance in initiating and funding this project. In addition, the author would like to acknowledge assistance provided by Karen Beppler, GEWA, and Mark Flora, NPS Water Resources Division, for technical review and guidance throughout the development of the Water Resources Management Plan. Mike Woodside and Ward Staubitz, U.S. Geological Survey, Richmond, VA, provided technical insights and assistance in the development of this plan, and David Vana-Miller assisted in the development of the Water Quality Monitoring Project Statement. John Storke and John Frye, GEWA, provided additional information and assistance. Finally, the author would like to thank the NPS Denver Service Center's Division of Micrographics for their production assistance.

APPENDIX

WATER-RESOURCE RELATED PROJECT STATEMENTS

Eight specific project statements developed for this Water Resources Management Plan are listed below in order of current priority. The priorities, however, are likely to change, as tasks are completed, more is learned about the water resources, and decisions are made, internally and externally, affecting the relative urgency of the various issues. These project statements will be inserted into the Natural and Cultural Resources Management Plan of the Monument, among the other resource management priorities.

GEWA-N-014.000	ENHANCE SURFACE WATER QUALITY MONITORING
GEWA-N-015.000	ASSESS CURRENT STATUS OF WETLAND RESOURCES
GEWA-N-010.000	ASSESS HISTORIC EROSIONAL PATTERNS AND MONITOR AREAS OF HIGH POTENTIAL RISK
GEWA-N-016.000	MONITOR LAND-USE IMPACTS ON WATER QUALITY
GEWA-N-017.000	DETERMINE CONCENTRATIONS OF PESTICIDES IN BOTTOM SEDIMENTS, SURFACE WATER, AND GROUNDWATER
GEWA-I-009.000	ENHANCE INTERPRETATION OF WATER-RELATED NATURAL AND CULTURAL RESOURCE ISSUES
GEWA-N-018.000	ASSESS SOIL EROSION/SEDIMENT DEPOSITION DYNAMICS IN POPES CREEK ESTUARY
GEWA-N-019.000	INVESTIGATE CHEMICAL PROCESSES AND THE INTERACTION BETWEEN GROUNDWATER AND SURFACE WATER SOURCES AT GEORGE WASHINGTON BIRTHPLACE NM

GEWA-N-014.000

Last Update: 12/11/97
Initial Proposal: 1997

Priority: 1
PS page: 1

Project Statement

Title: **ENHANCE SURFACE WATER QUALITY MONITORING**

Funding Status: Funded: 0.00 Unfunded: 6.10 (RECURRING ANNUAL COST)

Servicewide Issues: N11 (WAT QUAL-EXT)

N-RMAP Program codes: Q01 (Water Resources Management)

Problem Statement

George Washington Birthplace National Monument (GEWA) is a 550-acre unit of the National Park System along the banks of the tidal portion of the Potomac River in Westmoreland County, Virginia. While the primary purpose of the park is the preservation of the historic setting, the park contains significant water-related resources including Popes and Bridges Creek, whose tidally-influenced estuaries support extensive and diverse wetlands, Digwood Swamp and Dancing Marsh, which are comprised of significant freshwater wetlands, and a number of small streams, ponds, and springs, many of which are closely linked with the cultural and historic context of the site.

The Monument is located primarily within two small sub-basins (Popes Creek and Bridges Creek), whose watersheds are primarily rural in nature. However, the proximity of the park to the Washington, DC metropolitan area is expected to cause increased future developmental pressures, as roads are improved and sewer lines installed. Water quality issues related to future growth potential are discussed in more detail within the George Washington Birthplace National Monument Water Resources Management Plan.

Description of Recommended Project or Activity

The Water Resources Management Plan recognizes the need for a simple, yet effective, long-term water quality monitoring program. While a program to monitor all of the possible impacts from various nonpoint sources would be extremely costly and is not warranted, the park needs to assure the existence of a long-term monitoring program designed to: 1) flag potential degradation resulting from nonpoint source contamination; 2) provide a more complete assessment of baseline water quality; 3) periodically appraise the health of the aquatic ecosystem; 4) incorporate appropriate quality assurance/quality control procedures; and 5) be implemented in such a manner that data collected are comparable to data from existing state and federal monitoring efforts being undertaken.

In 1997 the Virginia DEQ Piedmont Regional Office evaluated its monitoring program within the tidally influenced embayments along the lower Potomac River. This evaluation resulted in the establishment of several new stations, including one in Popes Creek (STORET Station No. 1APOP00.38). Beginning in July, 1997 this station will be sampled on a bimonthly basis for water quality constituents including temperature, dissolved oxygen, pH, specific conductance, alkalinity, hardness, BOD5, COD, orthophosphate, total phosphorus, ammonium+nitrite+nitrate, total Kjeldahl nitrogen, chlorine, sulfate, total volatile solids, total fixed solids, total suspended solids, and fecal coliform bacteria. The Virginia DEQ also analyzes for approximately 20 heavy metals or pesticide contaminants in the sediments on an annual basis. In addition, if the concentration of any of the above constituents exceeds the Commonwealth's water quality standard, a special study would be performed where the Virginia DEQ would measure those parameters exceeding the standard at all accessible bridges on the tributaries of Popes Creek in an attempt to pinpoint the source of pollution. (Mark Alling, Virginia DEQ, Piedmont Regional Office, personal communication, 1997).

Because of the importance of this monitoring site in determining water quality trends in Popes Creek, working with Virginia DEQ to assure the long-term inclusion of this station within their monitoring program should be the highest priority of the park's water quality program.

In addition, Virginia DEQ operates a water quality monitoring station (STORET Number 1AMA0007.46) on Mattox Creek at River Mile 7.5, monitoring water quality in the portion of the stream that is freshwater, nontidal. Data from this station is currently used as by Virginia DEQ as an indicator of water quality conditions for other watersheds in the "accounting unit" including Bridges Creek and Pope's Creek. While this approach may be useful to the State as a cost-effective method for water quality assessment under the Clean Water Act, from the point-of-view of GEWA, nothing should replace ambient water quality measurements. However, given the relatively high cost of operating a water quality monitoring station similar to those on Mattox and Popes Creek, an inexpensive yet effective, monitoring tool is needed to flag potential problems upstream of the park. Biological monitoring is one such tool.

Presently, comprehensive approaches in biological monitoring have been developed and are being adopted by state and federal agencies. Forty-seven states, including Virginia, now use multimetric biological assessments of biological condition. It is recommended that biological assessment stations be located in the nontidal, freshwater portions of Popes and Bridges Creeks subbasins. In particular, Route 3 could be used as the access to the nontidal, freshwater portions of these creeks.

The Piedmont Region of Virginia DEQ conducts biological monitoring at 26 sites; however, none are located in the GEWA area. This region uses a particular form of a multimetric index known as Rapid Bioassessment Protocol II (Plafkin et al. 1989). This protocol uses the systematic field collection and analysis of major aquatic macroinvertebrate taxa. Identification is conducted in the field and analysis is via eight metrics that measure various aspects of the macroinvertebrate community. Because of the familiarity of and expertise on Rapid Bioassessment Protocol II in Virginia, GEWA is encouraged to enhance the current water quality monitoring program by conducting annual biological monitoring using the same protocol.

Prior to sampling at each water quality monitoring station, black and white photographs should also be taken looking upstream and downstream of the station. Photographic monitoring is an inexpensive method to assess changes in stream geomorphology, the riparian zone, and other physical habitat features that may be associated with site and watershed conditions. This series of photographs will also allow detection of slow, progressive changes in physical habitat features that otherwise might go undetected until the accumulation of impacts is noticeable.

With the establishment of any water quality monitoring program, a water quality monitoring implementation protocol should be developed. This protocol should establish a quality assurance/quality control program. This program would include, at the least, the delineation of field sampling and laboratory analytical methods, data storage and retrieval methods, and data analysis and interpretation. Annual summary reports should be prepared. These reports should include the tabular presentation of the data, data analysis, and data interpretation.

The implementation of the water quality monitoring program will require expertise and laboratory resources extending beyond the current resources of the park. Thus it is recommended that the Monument work with other federal, state, and local agencies, the NPS Water Resources Division, and appropriate local universities capable of providing the necessary field equipment, laboratory resources, and QA/QC protocols for recommended field sampling and laboratory analysis.

Estimated Annual Budget*

Year	Activity	Cost
1	Phase II Biological Assessment (2 sites)	$ 4,000
1	Photographic Documentation	$ 100
2	Report Preparation	$ 2,000
	TOTAL	$ 6,100

* This program is designed as an on-going supplement to Virginia DEQ monitoring efforts and would be a recurring cost.

Compliance Codes: EXCL

Explanation: 516DM2 App. 1.6

Literature Cited

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K.Gross, and R.M. Hughes, 1989, Rapid Bioassessment Protocols for Use in Streams and Rivers, Benthic macroinvertebrates and Fish: EPA 440-4-89-001, Office of Water Regulations and Standards, U.S. Environmental Protection Agency, Washington, D.C.

Last Update: 12/11/97
Initial Proposal: 1997

Priority: 2
PS page: 1

Project Statement

Title: **ASSESS CURRENT STATUS OF WETLAND RESOURCES**

Funding Status: Funded: 0.00 Unfunded: TBD

Servicewide Issues: N11 (WAT QUAL-EXT)

N-RMAP Program codes: Q01 (Water Resources Management)

Problem Statement

George Washington Birthplace National Monument (GEWA) is a 550-acre unit of the National Park System along the banks of the tidal portion of the Potomac River in Westmoreland County, Virginia. While the primary purpose of the park is the preservation of the historic setting, the park contains significant wetland resources. These include Popes Creek, which widens into a a broad, tidally-influenced estuarine embayment (approximately 1.25 miles long and.5 miles wide) above its confluence with the Potomac River, as well as extensive palustrine wetlands located along Bridges Creek and within Digwood Swamp and Dancing Marsh (fig.1) These wetland areas within the Monument provide important habitat for fish species, migrating waterfowl, and endangered species, including the bald eagle.

A series of studies were undertaken between 1976 and 1884 by the Virginia Institute of Marine Sciences (VIMS) to document changes in wetland vegetation over time, in an area known as Longwood Swamp which is a tidally-influenced estuarine wetland located near the mouth of Popes Creek. While the methodologies used in these studies changed as analytical methods for wetlands assessment improved, it is possible to make general comparisons based upon the results of these three studies.
Mercer (1989) delineated wetlands in the Longwood Swamp area near the mouth of Popes Creek, producing a vegetation may that indicated a major shift in wetlands species from 1976, when up to 90% of the wetlands vegetation consisted of marsh elder (*Iva frutescens)* (Mercer, 1978) to a species composition in 1985 containing a much lower preponderance of marsh elder (53%) but an increased abundance of marsh grasses including *Spartina alterniflora*, *Spartina cynosuroides,* and *Spartina patens* (Wilcox, 1989). Although uncertain as to the mechanism causing the apparent species shift, Wilcox(1989) speculated that erosion might be a factor and by comparing aerial photography from 1937, 1953, and 1985 was able to show that erosion within this portion of Longwood Swamp has been extensive (Wilcox, 1989).

Silberhorn and Shields (1995) conducted field transects and compared vegetation maps from 1985 and 1994 in order to further document changes within the Longwood Swamp marsh community. They documented a further loss of 1.76 hectares of marsh between 1985 and 1994, further impacts in marsh vegetation due to sand overwash, and a dynamic geomorphic change in the creation of a recurved spit that had developed since 1985 at the inlet end of the narrow barrier beach (Silberhorn and Shields, 1995). In addition, there was a further shift in vegetative community with the marsh elder (Iva frutescens) covering 72% of the total marsh complex as compared to only 27% in 1985, and a corresponding decrease in the marsh grasses (Spartina spp.)

Description of Recommended Project or Activity

The shoreline of the Potomac River within the vicinity of the Monument is very active, as evidenced by litter of uprooted trees, shrubs, and other flotsam, as well as documented by erosional studies undertaken by French (1985), and several unpublished NPS assessments (John J. Frye, George Washington Birthplace National Monument, oral commun., 1997). Wilcox (1989) reported a 50% loss of wetlands in the Longwood Swamp complex between 1937 and 1985. From 1985 to 1990, Hardaway and others (1992) report that from 1985-1990 approximately 30% of the reach of the Potomac River within the vicinity of the Monument was hardened with structures such as bulkheads and/or stone revetments further constricting sand movement along the shoreline. These, as well as other factors, could potentially affect the functioning of wetland areas along lower Popes Creek.

It is indeed rare for a NPS unit to have as much reliable archival data pertaining to shoreline processes and wetland delineation as is currently available to the Monument. However, the apparent continual loss of wetland areas, uncertainty as to the causal mechanisms behind these changes and the ultimate importance of this resource to the local ecosystem are high priority concerns of the Monument's management.

The objectives of this proposal are as follows:

- Conduct an assessment of the functions and values of the wetland communities in and adjacent to the Monument, possibly utilizing newly developed hydrogeomorphic (HGM) approaches for the assessment of wetland functions;
- Undertake research to better understand the causes of change in the local coastal morphology, and how these changes are affecting the characteristics and functions of the wetland community within and adjacent to the Monument;
- Delineate, digitize, and map marsh plant communities on a not greater than 10-year basis, and compare them with studies undertaken in 1985 and 1994;

The implementation of this project statement will require expertise and laboratory resources extending beyond the current resources of the park. Therefore, the Monument will work with other federal and state agencies and the Virginia Institute of Marine Sciences in further scoping out and refining techniques necessary to complete the proposed studies.

Estimated Budget

A budget for this proposal will be developed in consultation with the Virginia Institute of Marine Sciences, College of William and Mary, Gloucester Point, VA and other potential cooperators.

Compliance Codes: EXCL
Explanation: 516DM2 App.1.6

Literature Cited

French, Greg, 1985, Erosion rates along the coastal boundaries of George Washington Birthplace National Monument: Report to the National Park Service, Department of Geography, University of Maryland, College Park, MD, 42 pp.

Hardaway, C.S., Thomas, G.R., Glover, J.B., Smithson, J.B., Berman, M.R., and Kenne, A.K., 1992, Bank Erosion Study, SRAMSOE #319, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA, 73 p.

Mercer, J. L., 1978, Westmoreland County Tidal Marsh Inventory, SRAMSOE Report No. 59, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, VA 108 p.

Silberhorn, G.M., and Shields, Jeffrey, 1995. Change Detection Study of Vegetation and Area of Popes Creek Tidal Marsh Complex - GEWA: Virginia Institute of Marine Science Contract Report CA 4000-1-2-21, 9 p.

Wilcox, J. K., 1989, Recent vegetation and area changes in a tidal marsh located at Popes Creek, Virginia; M.A. Thesis, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA, 41 p.

Last Update: 12/11/97
Initial Proposal: 1997

Priority: 3
PS page: 1

Project Statement

Title: **ASSESS HISTORICAL EROSIONAL PATTERNS AND MONITOR AREAS OF HIGH POTENTIAL RISK**

Funding Status:	Funded: 0.00	Unfunded: 53.1
Servicewide Issues:	N09 (COASTAL DYNAM)	
	N11 (WATER QUAL - EXT)	
N-RMAP Program codes:	G05 (SHORELINE MANAGEMENT)	
	Q00 (WATER RESOURCES MANAGEMENT)	

Problem Statement

George Washington Birthplace National Monument (GEWA) is a 550-acre unit of the National Park System along the banks of the tidal portion of the Potomac River in Westmoreland County, Virginia. While the primary purpose of the park is the preservation of the historic setting, the park contains significant water-related resources including Popes and Bridges Creek, whose tidally-influenced estuaries support extensive and diverse wetlands, Digwood Swamp and Dancing Marsh, which are comprised of significant freshwater wetlands, and a number of small streams, ponds, and springs, many of which are closely linked with the cultural and historic context of the site.

The dynamics of sediment movement in the Popes Creek estuary includes not only sediment input by tributaries to Popes Creek, but also longshore movement of sediment in the Potomac River and into Popes Creek, and ongoing erosion of the scarps between GEWA and the Potomac River shoreline. Some potential archeological sites, including the colonial homesite of Henry Brooks as well as what have been identified as Indian middens, are now within 250 feet of the bluffs along the Potomac River. Wilcox (1989) and Silberhorn and Shields (1994) documented a consistent decrease in the acreage of marsh at the mouth of Popes Creek in comparison with a wetlands inventory by Mercer (1978). Although each report suggested erosion and (or) sedimentation as a factor that may have affected the loss of marsh, no measured sedimentation/erosion rates are available that may help in addressing the hypotheses. Erosion rates in the Popes Creek basin probably are high because of natural erosion of the steep slopes along waterways, and accelerated sediment yields from agricultural use of the land.

Description of Recommended Project or Activity

As noted in the Water Resources Management Plan, GEWA is located in a geomorphically dynamic environment, above scarps along the Potomac River and Popes Creek estuary. To preserve the natural and historic resources of GEWA, the park must assess the impacts of erosion and sedimentation and document the long term changes in natural landforms in the park. This assessment can be accomplished by the following tasks:

- Analyze historic aerial photography beginning in the 1930's using existing data sets from GEWA, and digitize those that have not been digitized. Have aerial photography flown contemporaneously with ground-truthing, to analyze changes in wetlands and other landforms up to the present throughout Popes Creek Basin and along the Potomac River shoreline.

• Conduct a bathymetric survey of Popes Creek estuary to map current water depths and location of wetland areas. Bathymetry may be used to pinpoint areas that are potential erosional and depositional areas. In addition, bathymetric mapping will document current depths to look at changes in future.
• Conduct cross-sectional surveys of stream channels and floodplains upstream of Popes Creek. Cross-sectional stream morphology may establish the relative sources and movement of sediment to the estuary and help predict possible future effects on the estuary.
• Periodic repetition of analysis of aerial photography and bathymetry and cross-sectional surveys (i.e., 5-year intervals) would provide an ongoing documentation of changes at the Monument, once initial methods were established.

Estimated Budget

Year	Activity	Cost($1000)
1	Analysis of aerial photography/ QA of existing data sets	10.5
1	Aerial photography	5.0
	Ground truthing	7.0
1	Bathymetric mapping	10.2
1	Stream transect surveying	10.2
2	Data analysis and reporting	10.2
	Total	53.1

Compliance Codes: EXCL
Explanation: 516 DM App.1.6

Literature Cited

Mercer, J. L., 1978, Westmoreland County Tidal Marsh Inventory SRAMSOE Report No. 59, Virginia Institute of Marine Sciences.

Silberhorn, G.M., and Shields, Jeffrey, 1995. Change Detection Study of Vegetation and Area of Popes Creek Tidal Marsh Complex - GEWA: Virginia Institute of Marine Science Contract Report CA 4000-1-2-21, 9 p.

Wilcox, J. K., 1989, Recent vegetation and area changes in a tidal marsh located at Popes Creek, Virginia; M.A. Thesis, Virginia Institute of Marine Science, 41 p.

Last Update: 12/11/97 Priority: 4
Initial Proposal: 1997 PS page: 1

Project Statement

Title: **MONITOR LAND-USE IMPACTS ON GROUND-WATER QUALITY**

Funding Status: Funded: 0.00 Unfunded: 28.4

Servicewide Issues: N11 (WATER QUAL -EXT)

N-RMAP Program codes: Q00 (Water Resources Management)

Problem Statement

George Washington Birthplace National Monument (GEWA) is a 550-acre unit of the National Park System along the banks of the tidal portion of the Potomac River in Westmoreland County, Virginia. While the primary purpose of the park is the preservation of the historic setting, the park contains not only accessible surface water resources, including estuaries, freshwater wetlands, streams and ponds, but also significant groundwater resources, which not as readily studied. Groundwater resources at GEWA include shallow aquifers that are pumped locally for agricultural uses, and that discharge to the surface water on-site through springs and seeps. In addition, deeper aquifers at GEWA currently serve as the water supply to the Monument and nearby farms and businesses. Many of the water resources are closely linked with the cultural and historic context of the site. Historically, however, groundwater has been the primary source of drinking water, from springs and shallow wells during colonial times, and from deep wells during modern times.

GEWA was intensively farmed prior to designation as a national monument, as was much of the property in the area. Agricultural areas often are associated with increased concentrations of nutrients, bacteria, and pesticides in both surface- and groundwater. After designation as an historic site, the Monument was protected from uncontrolled agricultural development, and much of the land previously cleared for fields was reforested, although agricultural uses continue. However, the movement of natural groundwater is very slow, and the rate of flushing of any contamination in the groundwater may depend on the hydraulic conductivity, rainfall, and other conditions of an area. Recent work in age-dating waters in other parts of the Coastal Plain of Virginia indicate that groundwater in surficial aquifers may take from years to centuries to be discharged (Hamilton and Shedlock, 1993).

No coordinated collection of groundwater water-quality samples has been conducted in the past, making the assessment of the groundwater difficult. Historic land use information for the site that might clarify sources of any contamination is limited, although aerial photographs are available for approximately every 10 years since the 1930's.
Occasional water samples collected from springs at GEWA and in nearby Westmoreland State Park over a span of years showed relatively high nitrate concentrations (unpublished records on file at U.S.Geological Survey, Virginia District Office). Also, limited historic water-quality samples from surface water indicated the presence of fecal indicator bacteria, which led to condemnation of Popes Creek for shellfishing in 1972 (Virginia Department of Environmental Quality and Virginia Department of Conservation and Recreation, 1996).

Throughout the Northern Neck, the potential for groundwater use has increased with urbanization pressure from the Washington, D.C. area, and as the Northern Neck counties develop in response. Ongoing monitoring of the quality of the deeper groundwater resources will be of increased importance as the population in the Northern Neck increases and the aquifers are used over a wider area. Groundwater-quality monitoring and assessment will provide managers with information necessary to determine the susceptibility of aquifers to water-quality changes in response to regional land-use changes. In addition, to assure the protection of sensitive ecological environments both within the Monument and outside the Monument, the quality of shallow groundwater that discharges into surface-water bodies should be examined with respect to land use.

Description of Recommended Project or Activity

To continue to protect natural resources of GEWA, it is recommended that the potential impact on water-quality with respect to land use be assessed for the basins in which GEWA is located. Recommendations for the sampling assessment include the following:

- Documentation of the current water chemistry of the shallow and deep aquifers.
- Age-dating of the aquifers at GEWA using chlorofluorocarbons (CFC's) to provide information on timing and processes involved in nutrient movement in the surface- and groundwater. The CFC age-dating procedure is used to quantify the length of time since the sampled water was exposed to the atmosphere, and is currently being used to age-date groundwater discharge into Chesapeake Bay from other sites in the Virginia Coastal Plain, as part of the USGS Chesapeake Bay Ecosystem Program.
- Land-use data from aerial photography and other available land-use documentation should be digitized as part of a GIS (geographic information system) for GEWA, to document past and present land use within the Popes Creek, Bridges Creek, and unnamed creek basins. This information can then be used to examine possible influences of land use on the ground-water system at the Monument.

Estimated Budget

Year	Activity	Cost($1000)
1	Water-quality Sampling	11.0
1	Laboratory - general	7.9
1	Laboratory - CFC's	4.5
1	Travel and vehicles	2.0
1	Supplies	3.0
	TOTAL	28.4

Literature Cited

Hamilton, P.A., and Shedlock, R.J., 1992, Are fertilizers and pesticides in the ground water?: U.S. Geological Survey Circular 1080, 16 p.

Virginia Department of Environmental Quality, and Virginia Department of Conservation and Recreation, 1996, Virginia Water Quality Assessment for 1996 and Non-point Source Pollution Watershed Assessment Report: 305(b) Report to EPA and Congress, April 1996, variously paginated

GEWA-N-017.000

Last Update: 12/11/97
Initial Proposal: 1997

Priority: 5
PS page: 1

Project Statement

Title: **DETERMINE CONCENTRATIONS OF PESTICIDES IN BOTTOM SEDIMENTS, SURFACE WATER, AND GROUNDWATER**

Funding Status: Funded: 0.00 Unfunded:31.4

Servicewide Issues:

N-RMAP Program codes:

Problem Statement

George Washington Birthplace National Monument is located within three subbasins, each of which was intensively farmed in the past. The subbasins, Popes Creek, Bridges Creek, and an unnamed creek, direct their streamflow from a total of 13,000 acres toward GEWA, and each of the three streambeds borders or is contained within GEWA. Historically, pesticides used in farming have included a range in chemicals from hydrophobic, or nonmiscible with water, to hydrophilic, or water-soluble, and may include some metal-based compounds. Hydrophobic pesticides tend to be persistent in the environment, and if not utilized in the pesticidal process, are retained in sediments for long periods. They may remain toxic if disturbed and allowed to reenter the environment, affecting viability of plants and wildlife. Some hydrophilic pesticides such as atrazine and arochlor have been found in both surface and groundwater. Depending on dilution factors, concentrations may have an effect on the diversity and amounts of vegetation growing in the estuary. Examples of pesticides with documented use in the Chesapeake Bay watershed include DDT, chlordane (both banned), arochlor and atrazine (in use).

In 1997 the Virginia DEQ Piedmont Regional Office evaluated its monitoring program within the tidally influenced embayments along the lower Potomac River. This evaluation resulted in the establishment of several new stations, including one in Popes Creek (STORET Station No. 1APOP00.38). Beginning in July, 1997 this station will be sampled on an annual basis for approximately 20 heavy metals and pesticide contaminants in the sediments. If the concentration of any of the constituents exceeds the Commonwealth's water quality standard, a special study would be performed where the Virginia DEQ would measure the constituents exceeding the standard at all accessible bridges on the tributaries of Popes Creek in an attempt to pinpoint the source of pollution. (Mark Alling, Virginia DEQ, Piedmont Regional Office, personal communication, 1997). Because of the importance of this monitoring site in determining water quality trends in Popes Creek, working with Virginia DEQ to assure the long-term inclusion of this station within their monitoring program should be a high priority of the park's water quality program.

In general, historic period of pesticide use, current presence or absence in the sediments, and concentrations of pesticides used have not been investigated in the area around GEWA. Dredging of sediments for mosquito control and possibly boating in parts of Popes Creek has been recorded in the past, however. Certain pesticides may be accumulated in fish tissue via consumption of minute amounts of the chemical in flora or fauna that live or grow in contaminated sediments. An analysis of fish tissue would document any current accumulation available to wildlife, and an areal survey of bottom sediment would look at the variability of hydrophobic pesticides throughout the estuary. Documentation of the presence or absence of contemporary hydrophilic pesticides would be valuable in protecting resources at GEWA that are susceptible to current input from the surface, including the estuaries and wetlands, ground water, and aquatic wildlife and vegetation. Although no further dredging is planned, a specific investigation of pesticides in the water, sediment and in fish tissue would be useful information to document and protect for the future the surface- and groundwater resources at GEWA.

Description of Recommended Project or Activity

- Selectively sample bottom sediments in Popes Creek, and, using GC/FID methodology, scan for presence or absence of hydrophobic pesticides. Sample cores should be collected at areas known to have been dredged as well as areas that have not been dredged, in a grid throughout Popes Creek. Analyze any samples that show presence of pesticides to determine concentrations.
- Sample selected groundwater wells, springs and surface water and, using GC/FID methodology, scan for presence or absence of hydrophilic pesticides. Analyze any samples that show presence of pesticides to determine concentrations.
- Document findings in a report, map(s), or other format that best meets the needs of the National Park Service. In addition, document findings in the Monument's Geographic Information System for future use by Natural Resource Managers at the Monument.

Estimated Budget

Year	Activity	Cost($1000)
1	Project management and sampling	6.8
1	Laboratory costs (GC/FID scan for sediment and water)	4.5
1	Laboratory costs (specific analyses)	13.0
1	Supplies	3.0
1	Travel, vehicles, postage	.9
2	Reporting	3.2
2		
	TOTAL	31.4

Last Update: 12/11/97
Initial Proposal: 1997

Priority: 6
PS page: 1

Project Statement

Title: **ENHANCE INTERPRETATION OF WATER-RELATED NATURAL AND CULTURAL RESOURCE ISSUES**

Funding Status: **Funded: 0.00** **Unfunded: 25.0**

Servicewide Issues:

N-RMAP Program codes:

Problem Statement

The natural setting of George Washington Birthplace National Monument is unique in that water-related natural resources are both visible and easily accessible, and may serve as an excellent means of demonstrating to the public the interaction between precipitation, groundwater, surface water, and the flora and fauna of the ecosystem. At this site, water resources include: freshwater streams and wetland areas specific to freshwater ecosystems; a brackish-water estuary with both fresh-and-saltwater tolerant wetlands and submerged aquatic vegetation; springs; and the marine, avian, and terrestrial fauna that inhabit each of these areas. Often, it is difficult to relate the mechanism of the hydrologic cycle and man and nature's relation to it in terms that can be visualized by people with a broad range of experience. The varied topography of the site facilitates the understanding of water movement from the surface into the groundwater, and back out to the surface. The GEWA site is large enough to contain a variety of landforms yet small enough to be able to see many processes that occur at land/water interfaces and at surface water/groundwater interfaces, along with the resultant diversity in the ecosystems.

Description of Recommended Project or Activity

Create a natural resources guide, display, or sets of outdoor displays showing the unique natural resources of GEWA. These displays may be used to demonstrate to the park visitor the unique water-related characteristics of the site, and to illustrate the natural ongoing processes in and around the Chesapeake Bay ecosystem. Suggested topics include:

- Freshwater stream versus brackish water estuary – Create a map showing differences between the estuary and the incoming freshwater sources. Compare fisheries, wildlife and differences in vegetation.
- Hydrologic cycle - Illustration of movement of water through the cycle: precipitation, filtering through soils, and discharging at springs. Integrate with field trip to spring, and address effects of man's impact on groundwater and eventually surface water quality, from agriculture and development.
- Beaches - Illustrate movement of sand /sediment along the shore, and, using bathymetric map, show "piling" of sand near GEWA, and erosion at different places of the Potomac River upstream as a result of the hydraulics of the river system.
- Marshes - Identify different marsh grasses - fresh versus saltwater marshes, and requirements for growth, such as water depth, and salinity.
- Document native plants and animals found in the park.

Estimated Budget

Year	Activity	Cost ($1000)
1-2	Produce outdoor exhibits to highlight water resources:	
	• Freshwater stream versus brackish water estuary	5.0
	• Hydrologic cycle with respect to landforms at Monument	5.0
	• Erosion and sedimentation along beaches	5.0
	• Identification of marsh grasses and shrubs	5.0
1-2	Document native and non-native plants and animals of the Monument	5.0
	TOTAL	25.0

Last Update: 12/11/97
Initial Proposal: 1997

Priority: 7
PS page: 1

Project Statement

Title: INVESTIGATE CHEMICAL PROCESSES AND THE INTERACTION BETWEEN GROUNDWATER AND SURFACE WATER SOURCES AT GEORGE WASHINGTON BIRTHPLACE NATIONAL MONUMENT

Funding Status:	Funded: 0.00	Unfunded: 45.2
Servicewide Issues:	N11 (WATER QUAL -EXT)	
N-RMAP Program codes:	Q00 (Water Resources Management)	

Problem Statement

George Washington Birthplace National Monument was intensively farmed prior to designation as a national monument, as was the property immediately surrounding it. After designation as an historic site, the land was protected from uncontrolled agricultural development, and much of the land previously cleared for fields was reforested, although agricultural use of the land continues. Limited historic water-quality data from surface water sampling indicated the presence of fecal indicator bacteria, which led to condemnation of Popes Creek for shellfishing in 1972 (Virginia Department of Environmental Quality and Virginia Department of Conservation and Recreation, 1996). Occasional reconnaissance sampling over a number of years showed relatively high nitrate levels in springs, indicating a possible relation between the historic usage of the land and the water quality (unpublished records on file at U.S. Geological Survey, Virginia District Office).

Presence of nutrients and bacteria as well as other changes in water-quality in and around the Monument may be in response to: 1) land use as affected by current development in the area; 2) processes ongoing from current and historic land uses, which can include movement of nutrients overland and (or) through the aquifers; and 3) mitigation activities such as agricultural best management practices that have been instituted at the Monument which may affect nutrient distribution and pathways. Contaminants frequently associated with agricultural areas include nutrients, bacteria, pesticides, and suspended sediment. Current monitoring of field measurements provides excellent background data, but will not always reveal long-term or ongoing changes in the water quality. Monitoring of selected chemical constituents, including nutrients and bacteria, would ensure more in-depth knowledge of the water resources of the Monument and will lead to a better understanding of nutrient movement and processes in the surface- and groundwater in this part of the Virginia Coastal Plain, as well as within the Chesapeake Bay watershed.

Description of Recommended Project or Activity

A targeted reconnaissance sampling program will be used to define the ground-water flow system and the influence on the surface water system at the Monument. The resultant data will be used to develop a continuing monitoring plan in order to: 1) assess the vulnerability of the public water supply to off-site contamination, and 2) assess the vulnerability of the Monument's tidal wetlands.

- Sample up to 5 ground-water wells once each for nutrients, major ions, and bacteria. Data will be used to document the condition of aquifers that are currently being used either for public supply or irrigation in and near the Monument from wells representative of the Potomac, Aquia, and Columbia aquifers. Ground water will age-dated once using chlorofluorocarbon (CFC) dating, which quantifies the period of time since the aquifer was recharged
- Sample up to 5 stream sites quarterly for nutrients, major ions, and bacteria (subject to flow conditions) in order to document seasonal variations. In addition, a maximum of 2 storm samples will be collected to document the normal range in concentrations. Stream water-quality samples will be point samples or cross-sectional/depth integrated samples, depending on stream size and flow conditions. Discharge will be measured when possible, depending on the size and tidal nature of the streams.
- Sample up to 3 springs twice each for nutrients, major ions, and bacteria (subject to flow conditions). Springs will be age-dated twice, once when aquifers are at a seasonal maximum, and once at a seasonal minimum, using chlorofluorocarbon (CFC) dating, which quantifies the period of time since the aquifer was recharged
- At all sites, collect oxygen/deuterium samples to establish isotopic signatures of the source waters of surface water, ground water, and springs. These data will be used in the evaluation of the hydrologic flow system.
- Sample Popes Creek early in the growing season to document presence/absence of pesticides in runoff from the basin. The shallow aquifer and springs will be sampled once each for pesticides, to document presence/absence of pesticides in the groundwater.

Estimated Budget

Year	Activity	Cost($1000)
1	Low-flow and stormflow sampling	9.9
1	Laboratory - general	19.0
1	Laboratory - CFC's	4.5
1	Travel and vehicles	2.0
1	Supplies	4.2
2.	Project Management and Reporting	5.6
	TOTAL	45.2

Literature Cited

Virginia Department of Environmental Quality, and Virginia Department of Conservation and Recreation, 1996, Virginia Water Quality Assessment for 1996 and Non-point Source Pollution Watershed Assessment Report: 305(b) Report to EPA and Congress, April 1996, variously paginated.

GEWA-N-020.000

Last Update:	12/11/97	Priority:	8
Initial Proposal:	1997	PS page:	1

Project Statement

Title: **Identify Best Management Practices for Watershed Protection**

Funding Status: Funded: 0.00 Unfunded:

Servicewide Issues: N11 (WAT QUAL)

N-RMAP Program codes: Q01 (Water Resources Management)

Problem Statement

George Washington Birthplace National Monument (GEWA) is a 550-acre unit of the National Park System located along the banks of the tidal portion of the Potomac River in Westmoreland County, Virginia. While the primary purpose of the park is the preservation of the historic agricultural-based setting, the park contains significant water-related natural resources including the Potomac River shoreline, Popes and Bridges Creeks, Digwood Swamp, Dancing Marsh, and a number of small streams, ponds, and springs. In many cases, these water-related features are closely linked with the cultural and historic context of the site.

The Monument, along with 46 other units of the National Park system, is also located within the 64,000 square mile Chesapeake Bay Basin. The watershed of Chesapeake Bay, North America's largest estuary, includes the drainages of the Susquehanna, Potomac, Rappahannock, York, and James Rivers and encompasses significant and diverse ecological areas of essential economic, recreational, and social value. Over the past two centuries the Bay, along with many of its tributaries, has suffered from the effects of industrialization, increased population growth and urbanization, decreasing wetland functions, and an accumulation of sediment and industrial wastes.

For the last several decades, federal, state and local agencies within the Chesapeake Basin have worked cooperatively to identify and implement activities designed to restore the ecological health and functions of the Chesapeake Bay. In 1994, the National Park Service, along with 36 other state and federal entities agreed to cooperate as "partners" working towards a common goal of restoring the Chesapeake Bay watershed. A National Park Service Chesapeake Bay Task Force has been established with the goal of identifying and implementing measures to meet this commitment.

Description of Recommended Project or Activity

The NPS Chesapeake Bay Task Force has identified the need to identify and implement Best Management Practices (BMPs) for Watershed Protection as a high priority in achieving NPS commitments. The first objective of this proposed project would be to identify which watershed protection issues were pertinent to which NPS units. Once the number of issues facing the number of parks is better understood, a strategy could be developed to review currently existing BMPs for the top priority issues. Each BMP alternative could be assessed as to its appropriateness for a unit of the National Park system, for its cost effectiveness, and for its projected benefits in furthering the goals of the Chesapeake Bay Program. A fact sheet and/or checklist then could be developed for each of the preferred alternatives, providing implementation guidance for NPS resource managers/facility managers. It is likely that the development of a "precision-guided" training program, focussing on selective issues and BMPs would then be a useful tool for providing information on these issues to field level managers at the affected NPS units.

The implementation of this project statement should be addressed as a multi-park effort in order to assure the availability of specialized expertise extending beyond the current resources of any one unit. Successful implementation of appropriate BMPs will also require close coordination among the NPS Chesapeake Bay Task Force members and the affected NPS units. Therefore, the Monument will work with the task force, as well as other local, state, and federal entities in the implementation of this project.

Estimated Budget

A budget for multi-park/multi-region effort to address this issue is currently being developed by the NPS Chesapeake Bay Task Force.

Compliance Codes: EXCL

Explanation: 516DM2 App. 1.6